AGRICULTURAL ENGINEERING

NOVEMBER • 1956

In this Issue . . .

ASAE Winter Meeting • Chicago, Ill., December 9 to 12

THE JOURNAL OF THE
AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS

Great New Line of CASE® Spreaders

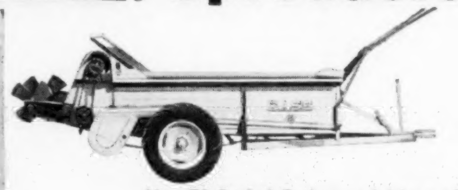
Only CASE® Dares to Make This Demonstration Offer!

Now you can have a manure spreader demonstration right on your own farm. All you do is to call up your Case dealer.

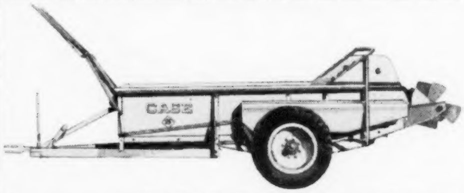
Nobody ever dared to make such an offer before! And Case can do it now only because of the extra strength and quality of the new Case spreaders.

Compare these four great Case spreaders, feature by feature, with any other make. Look at the extra strength built into the steel-ribbed, double-treated wood box, and rigid, channel steel V-hitch frame. Notice the enclosed or shielded roller chain drives and anti-friction bearings—hidden features that add extra years of trouble-free service. See how easily a Case Spreader pulls, how fine it shreds, how evenly it spreads. You won't have to peg-tooth new seedings!

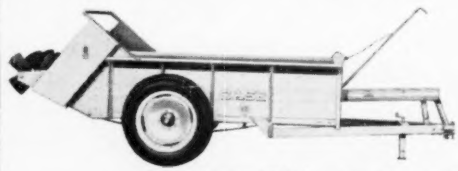
Pick up the phone now. Ask your Case dealer to bring out a Case spreader and power loader to your farm. Ask about the flexible Case Crop-Way Purchase Plan, too.



New 75-Bushel. Both ground-drive models have an adjustable slanting arch. Also heavy steel axles with exclusive center bearing to limit flexing.



Big 95-Bushel. Exclusive self-raising hitch on 75 and 95-bushel. All four spreaders have roller chain drives, plus independent apron control.



New 105-Bu. PTO. Spreader drive mechanism is fully enclosed to keep out dirt and trash. Slanting arch goes under barn cleaners; can't catch on low branches.

Big 125-Bu. PTO. Big capacity saves many trips. Handy screw stand makes hitching easy. Universal drive adjusts easily to tractor PTO height.

Send for 24-page Spreader Catalog

Get the complete story. Ask your dealer, or write to J. I. Case Co., Racine, Wis.

Name______________________________

Address______________________________

____

AGRICULTURAL ENGINEERING

Established 1920

CONTENTS · NOVEMBER, 1956 · Vol. 37, No. 11

Note: AGRICULTURAL ENGINEERING is regularly indexed by Engineering Index and by Agricultural Index. Volumes of AGRICULTURAL ENGINEERING, in microfilm form, are available (beginning with Vol. 32, 1951), and inquiries concerning purchase should be directed to University Microfilms, 313 N. First St., Ann Arbor, Michigan.

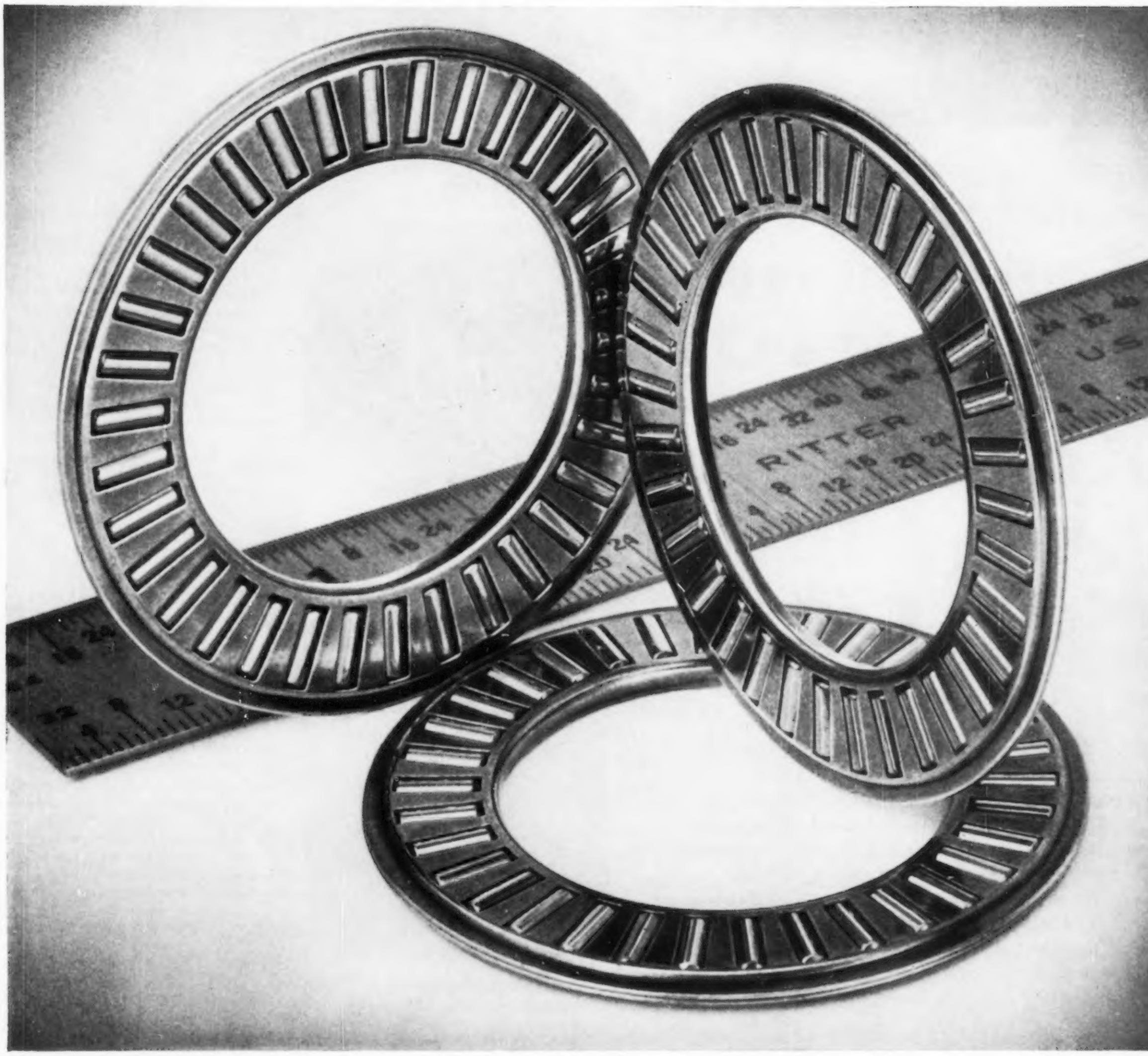
Central Office: 420 Main Street, St. Joseph, Michigan

AGRICULTURAL ENGINEERING is owned and published monthly by the American Society of Agricultural Engineers. Editorial, subscription and advertising departments are at the central office of the Society, 420 Main St., St. Joseph, Mich. (Telephone: YUkon 3-2700).

JAMES BASSELMAN,
Editor and Publisher

SUBSCRIPTION PRICE: $5.00 a year, plus an extra postage charge to all countries to which the second-class postage rate does not apply; to ASAE members anywhere, $3.00 a year. Single copies (current), 40 cents each.

POST OFFICE ENTRY: Entered as second-class matter, October 28, 1933, at the post office at Benton Harbor, Michigan, under the Act of August 24, 1912. Additional entry at St. Joseph, Michigan. Acceptance for mailing at the special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized August 11, 1921.



Here's the NEW Torrington Needle THRUST Bearing!

Now designers have available a *needle bearing* exclusively for heavy *thrust* loads.

This compact Torrington Needle Thrust Bearing—only .0781" in cross section—is no thicker than an ordinary thrust washer. Yet it brings all the advantages of anti-friction operation at low unit cost for many thrust applications.

Two mating retainer halves, highly accurate steel stampings, are securely joined to form a self-contained unit closed on OD and ID. The bearing can run directly on adjacent parts, hardened to act as races, or on economical hardened and ground flat races. The bearing is piloted on the retainer bore.

In any thrust application where low unit cost, high thrust capacity and compact design are primary factors, consider the Torrington Needle Thrust Bearing. Services of our Engineering Department are available to assist you with design and application.

Send for our new Bulletin, "No. 21 - - Torrington Needle Thrust Bearings," for full information.

Highly successful applications of the Torrington Needle Thrust Bearing have been made in automatic transmissions, governors, steering gears, bevel gears, hydraulic pumps, and torque converters.

THE TORRINGTON COMPANY
Torrington, Conn. • South Bend 21, Ind.
District offices and distributors in principal cities of United States and Canada

TORRINGTON BEARINGS

Needle • Spherical Roller • Tapered Roller • Cylindrical Roller • Ball • Needle Rollers

ONE OF A SERIES:

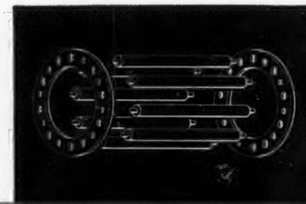
What makes a cylindrical roller bearing good?

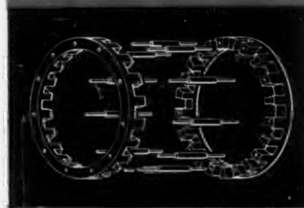
RETAINERS

"requirement-engineered" for your kind of service

The basic parts of a roller bearing are the rollers, the races, and the *retainer* which locates and guides the rollers. There are significant differences in the design and construction of retainers, which influence bearing cost and performance. Some are simple and economical, well adapted for volume production; others are more costly but insure improved roller guidance, or cooler and smoother operation, or longer heavy-duty service. Here are the seven basic types in current use.

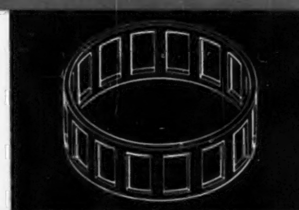
TRUNNIONED ROLLER CAGE—Economical for volume use on thin-annulus bearings. End rings are hardened steel stampings, connected by riveted bars interspersed between rollers to form an integral unit. Races can be omitted if desired.

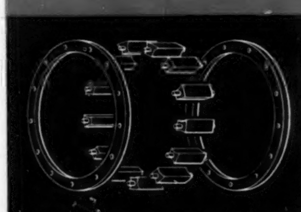




POCKETED END RING CAGE—Designed for fairly large bore bearings in heavy-duty service. Rollers are guided accurately by pockets drilled in bronze end rings. Riveted connecting bars form an integral unit, so races can be omitted if desired.

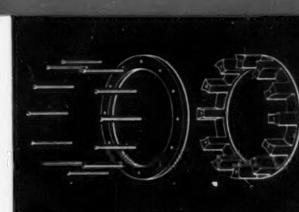
STAMPED STEEL SEPARATOR—Economical for volume use on wide range of bearings with short rollers. A single steel stamping with bars coined to conform to roller contour. Simple, open design assures large lubricant capacity and good circulation.

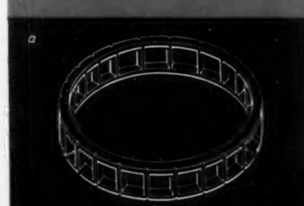




FORMED BAR CAGE—Well adapted for volume use on heavy-duty bearings. Hardened steel end rings are connected by cold-rolled shaped bars conforming to roller diameter. Insures quiet operation, better roller guidance, and the smooth surface of bars protects rollers.

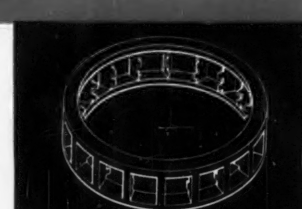
DRILLED POCKET CAGE—Used on better-grade bearings to provide extremely close control of rollers, which operate in pockets drilled and reamed in bronze cylinder. Riveted ring on one end retains rollers permanently, so races may be omitted if desired.





SEPARABLE BROACHED POCKET CAGE—Used only on finest high-speed bearings. An integral bronze cylinder with pockets broached for maximum uniformity. Insures minimum friction, better oil circulation for cooling. Rollers can be removed for inspection.

NON-SEPARABLE BROACHED POCKET CAGE—Similar to the above and offers all the same operating advantages. Used for "blind" installations where rollers must be retained with inner or outer race. Roller drop controlled by deforming bars after rollers are placed.



HYATT MAKES ALL SEVEN TYPES . . . EACH THE FINEST OF ITS KIND! You will find complete details in HYATT General Catalog No. 150, or your nearby HYATT Sales Engineer will gladly help you choose the type best suited to your requirements. Remember, HYATT is America's *first* and *foremost* maker of cylindrical roller bearings. Hyatt Bearings Division of General Motors, Harrison, New Jersey.

GM GENERAL MOTORS

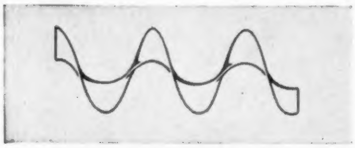
HYATT

HY-ROLL BEARINGS

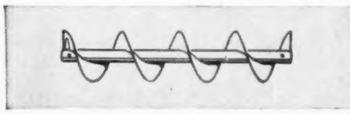
FOR MODERN INDUSTRY

Flexible in application . . . versatile in operation

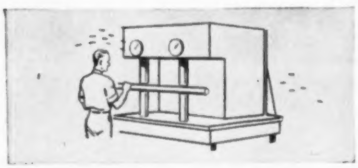
Link-Belt augers simplify design



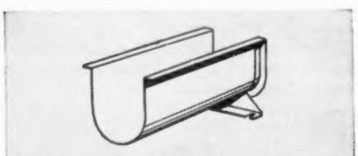
SELECTED FLIGHTING for all your auger needs. Helicoid, sectional or a range of other types of flighting are available in the metal and finish best suited for your design.



SIMPLICITY OF CONSTRUCTION and sturdy design of Link-Belt augers provide dependable, efficient operation on your machine. One basic assembly with no other moving parts to break down.



YOUR CHOICE OF METALS answers your requirements for handling corrosive or abrasive materials. And Link-Belt uses only specially selected steels to assure a uniform product.



ALL COMPONENTS — conveyor screws, collars, couplings, hangers, troughs, trough ends, flanges, drives —are available for every design.

ENGINEERING SERVICES. Our auger specialists will help you analyze your special needs . . . integrate all elements of your design.

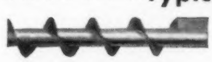
Four Link-Belt auger-conveyors on cotton-stripper provide positive, unobstructed delivery of bolls to kick-beaters. This is just one of the many applications for the full range of augers developed by Link-Belt.

You can be sure of efficient operation, long life and low maintenance when you make a Link-Belt auger part of your equipment.

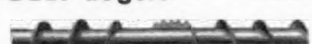
Link-Belt has a wide selection of augers, many of a specialized design, in a full range of diameters, gauges and pitches. They're accurately made to assure easy assembly, smooth, dependable operation. In addition, all components can be adapted to your particular design.

Whether it's a new application for your present machines or an entirely new concept, simplify your design problems by specifying Link-Belt augers. Call your nearest Link-Belt office for complete information.

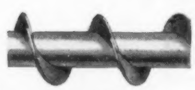
Typical LINK-BELT augers



Helicoid flight with plain beater



Opposed flights with center saw-tooth beater



Sectional flight

Helicoid flight

Unmounted Helicoid flighting

Write for LINK-BELT Screw Conveyor Book 2289

LINK-BELT

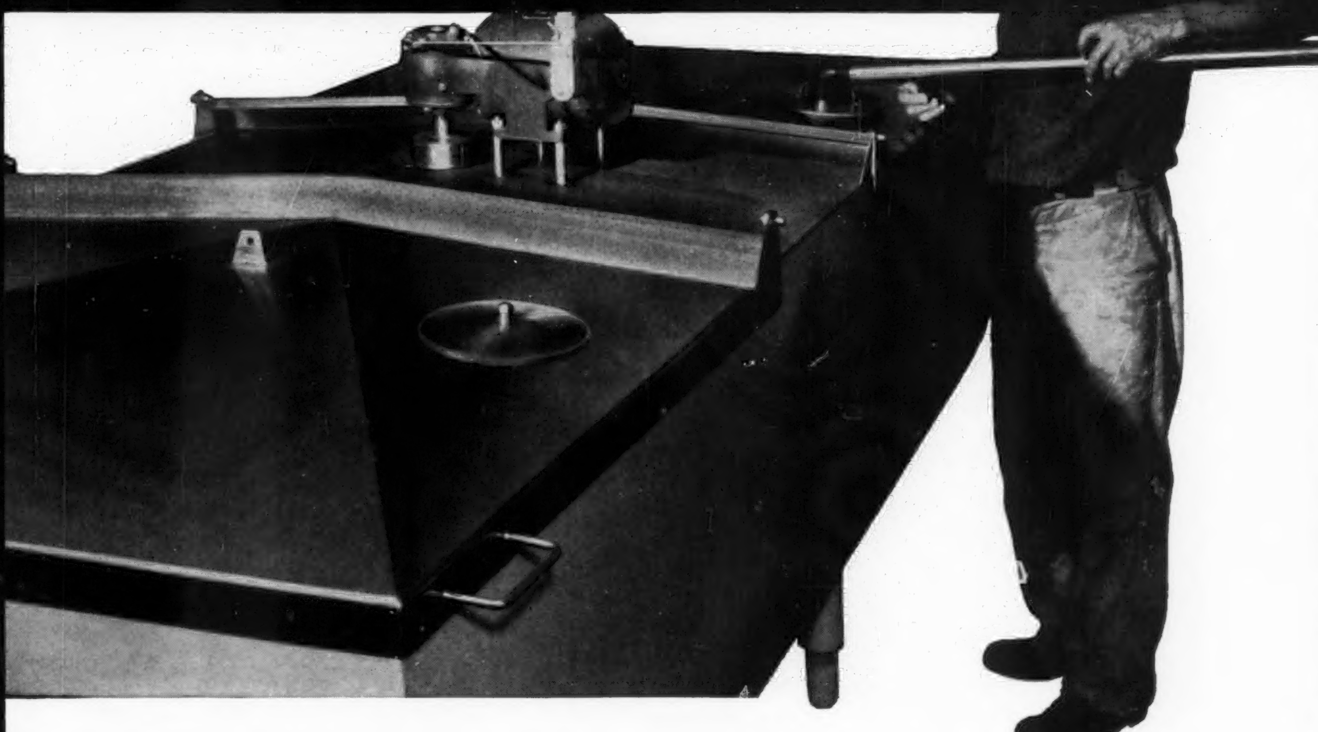
FARM MACHINE AUGERS

14,057

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.

"I get 26¢ per cwt. more for my milk using a bulk milk system ...and with half the labor"

says Ernest Braley—Bangor, Maine



Since he installed his 500-gallon, Stainless Steel bulk milk tank two years ago, Mr. Braley has averaged 400 gallons each pick-up (every other day). The tank holds the milk at 35°, and it takes only about 10 minutes to transfer the milk from tank to tanker.

Mr. Braley says, "The bulk milk system has cut our milking time in half—from about 4 man-hours to 1½ man-hours. Now, it's a one man job with 40 Holsteins. We save 10¢ per cwt. on hauling alone (25¢ vs. 15¢). Butterfat runs about two points higher, so that nets an extra 16¢ per cwt. We also save quite a bit on stickage, and bacteria count is low."

Bulk milk handling nets more to the farmer, more to the dairy, and it results in better-quality milk. It's the most efficient way to handle milk, and tanks made from USS Stainless Steel have been proving it all over the country. Send coupon for free booklet that answers many questions about the bulk milk handling system.

SEE The United States Steel Hour. It's a full-hour TV program presented every other week by United States Steel. Consult your local newspaper for time and station.

UNITED STATES STEEL CORPORATION, PITTSBURGH · AMERICAN STEEL & WIRE DIVISION, CLEVELAND
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO · NATIONAL TUBE DIVISION, PITTSBURGH
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA.
UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS STAINLESS STEEL

SHEETS · STRIP · PLATES · PIPE · TUBES · WIRE
BARS · BILLETS · SPECIAL SECTIONS

USS

Agricultural Extension
United States Steel Corporation, Room 5483
525 William Penn Place, Pittsburgh 30, Pa.

Please send me the free booklet on bulk milk handling equipment.

Name..

Town.................................RFD.............

County...........................State..............

UNITED STATES STEEL

Builds Easy Pickup Carrier

for Harrow and other Machines

L. B. Lawson *(right)* explains the operation of his home-made pickup carrier for field machines to Texaco Consignee M. A. Bergeron of Crowley, La. Mr. Lawson uses Marfak lubricant on all his equipment because it *cushions* the bearings, seals out grit and dirt and won't jar out, wash off, drip out or dry up. It sticks to bearings longer.

L. B. LAWSON and his brother farm 3,500 acres near Crowley, Louisiana. He found that dragging field machines, like the disk harrow, around to the various fields was quite a chore. He hit on the idea of an easy pickup carrier and built the device shown above. The materials included the front axle and wheels of an old car, some iron pipe and angle iron. He welded them together as shown in the illustration. He hitches the carrier to his tractor and picks up and transports harrows and other machines from field to field in a matter of minutes.

Like keen ranchers and farmers from coast to coast, both Mr. Lawson and his brother have found that *it pays to farm with Texaco products.*

J. W. Lawson *(left)* agrees with his brother L. B. that Fire Chief gasoline provides superior *"Fire-Power"* for low-cost operation on the farm. He is shown with his son W. E. *(right)* and Texaco Consignee M. A. Bergeron who provides the dependable service farmers and ranchers appreciate.

"Havoline Motor Oil keeps tractor engines cleaner so they deliver more power," says Martin Ball *(left)*, farmer, near Battle Creek, Michigan. Tests prove Havoline is the best motor oil money can buy. Mr. Ball's son is shown on tractor, Texaco Consignee Charles Gripe on right.

A Great New Source of Power

—in town or on the highway at Texaco service stations in all 48 states—is top octane Sky Chief gasoline, supercharged with Petrox, the exclusive all-petroleum additive. It's the ideal combination with Havoline Motor Oil for longer engine life and greater gasoline mileage.

THE TEXAS COMPANY

ON FARM AND HIGHWAY IT PAYS TO USE TEXACO PRODUCTS

DIVISION OFFICES: Atlanta, Ga.; Boston 16, Mass.; Buffalo 9, N. Y.; Butte, Mont.; Chicago 4, Ill.; Dallas 2, Tex.; Denver 3, Colo.; Houston 2, Tex.; Indianapolis 1, Ind.; Los Angeles 15, Calif.; Minneapolis 3, Minn.; New Orleans 16, La.; New York 17, N. Y.; Norfolk 10, Va.; Seattle 1, Wash.

Texaco Products are also distributed in Canada, Latin America, and Africa.

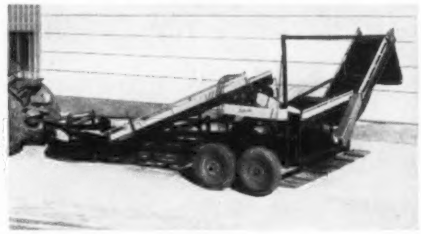
Whatever the crop... wherever it's grown...

CORN

New Idea Corn Picker - Husker

POTATOES

Lockwood Potato Harvester



the "New Look" in harvesters foretells a

COTTON

International Harvester Picker

GRAIN

Massey-Harris Combine

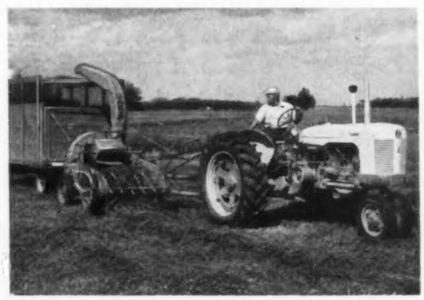
bright future for implements with modern

SUGAR BEETS

Scott Viner Harvester

SILAGE

J. I. Case Forage Harvester

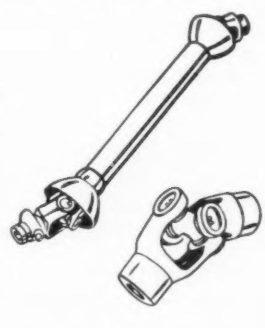


BLOOD BROTHERS Joints and Drive Lines

Yes, the "new look" in harvesters shows why farmers *must* and *will* buy more and more new equipment.

For as manufacturers offer faster, better implements that *produce enough more per labor hour*, farmers will make the machines pay for themselves.

On all these harvesters—and most other implements—Blood Brothers Drive Lines help keep costs down and add extra utility—two "buying reasons" farmers like!



FOR FARM IMPLEMENTS, MORE BLOOD BROTHERS UNIVERSAL JOINTS ARE USED THAN ALL OTHER MAKES COMBINED

TAKES POWER AROUND CORNERS

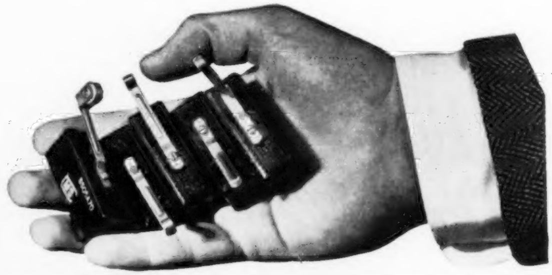
BLOOD BROTHERS MACHINE DIVISION

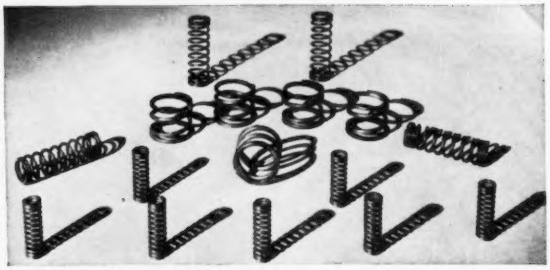
ROCKWELL SPRING AND AXLE COMPANY

ALLEGAN, MICHIGAN

UNIVERSAL JOINTS AND DRIVE LINE ASSEMBLIES

Two special Armco Stainless Steels simplify production... improve farm equipment parts



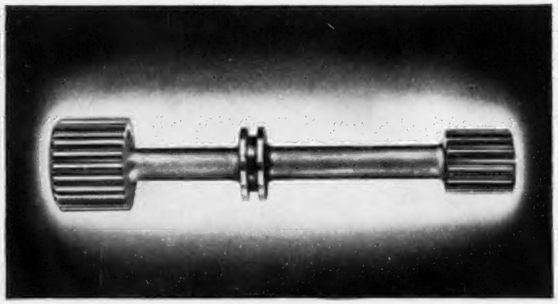


Are vital parts in your products . . . pump shafts, springs, flow meters, fasteners, carburetor components or bushings, . . . failing prematurely from corrosion or fatigue? Armco 17-4 PH and 17-7 PH, two precipitation hardening stainless steels, can give these parts excellent corrosion resistance, fatigue strength, and tensile strength. In addition, these special stainless steels offer fabricating advantages over other materials.

Here are some typical examples of how Armco precipitation hardening grades increase efficiency, prolong service life, and simplify fabrication of vital machinery parts.

High tensile strength

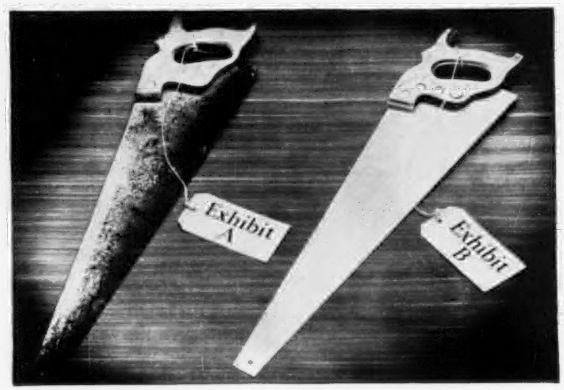
Armco 17-7 PH wire, when hardened, exhibits elastic properties like those of the best music wire and alloy spring steels. For the odd shapes required in applications such as switch actuators (upper photo), as well as conventional coil-type springs (lower photo), Armco 17-7 PH can be cold formed without breaking. Its remarkable mechanical properties are then developed with heat treatment at 900 F for 30 minutes.



High fatigue strength

Under accelerated fatigue tests, this pump shaft made of Armco 17-4 PH (above) lasted 30 hours. The next best metal in the identical test was a non-ferrous alloy. It lasted nine hours. Shafts of 4140 alloy steel and Type 440 C stainless steel lasted less than one hour.

Like all Armco 17-4 PH parts, this shaft was finish-machined in the annealed condition, then fully hardened with a low temperature heat treatment (875 F for one hour). No allowance for distortion or scaling during heat treatment is necessary. Armco 17-4 PH can also be forged or cast.



Good corrosion resistance

Armco 17-7 PH can be hardened to spring temper, yet it retains its good corrosion resistance. The two saws (above) were left on the ground side by side for 30 days. Corroded "Exhibit A" is ordinary carbon steel. The bright, rust-free "Exhibit B" is Armco 17-7 PH.

High spring quality and the excellent corrosion resistance of 17-7 PH also make it highly desirable for soil working shapes, such as discs and shovels.

For complete information on these special Armco Stainless Steels, just fill in the coupon and mail it to us.

ARMCO STEEL CORPORATION
2576 Curtis Street, Middletown, Ohio
Send me complete information on 17-4 PH ☐ 17-7 PH ☐
We design__________
Name__________
Company__________
Street__________
City__________ Zone_____ State__________

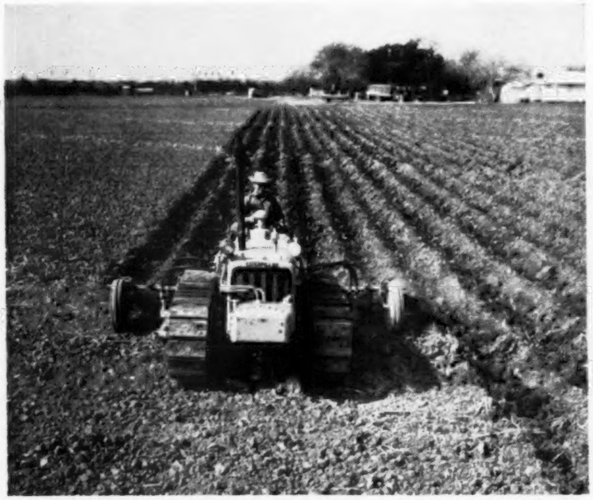
ARMCO STEEL CORPORATION
2576 CURTIS STREET, MIDDLETOWN, OHIO
SHEFFIELD STEEL DIVISION • ARMCO DRAINAGE & METAL PRODUCTS, INC., THE ARMCO INTERNATIONAL CORPORATION

ON-THE-FARM PICTURE REVIEW

DESIGNED TO SHOW THE MANY PROFITABLE USES OF CAT* EQUIPMENT

A TYPICAL DAY ON THE SHIMOTSU FARMS FINDS CAT DIESEL TRACTORS BUSY, MAKING OWNERS MONEY

Shimotsu Farms, San Benito, Texas, are large truck farmers, producing crops including cabbage, lettuce, tomatoes, potatoes, beets, peppers, onions, as well as cotton and cattle. Kingpins on the farms are three Cat D6 and D4 Tractors. They use them at every season of the year, leveling, disking, plowing, terracing and ditching. Here's a typical day's work:



Middle busting *50 acres per 8-10 hour day with Cat D4 Tractor and Tool Bar middle busters. This combination precision-builds 5 beds and furrows at a time.*

Pulling heavy loads *with the D6. The tractor handles a scraper plane for land forming, or a 6-bottom plow, and many other heavy jobs with speed, efficiency and economy.*

Deep disking *60 acres a day, one phase of seedbed preparation. The D6 is also used for tool bar subsoiling and ditching as well as other essential work.*

Good service *is expected — and received — from Cat equipment and while dealer service is seldom needed, Shimotsu's local dealer is always ready.*

Modern agriculture demands abundant power and the traction to use that power. Power and traction to plow and subsoil — to grade and form crop lands — to build dams, control erosion, develop watersheds. This is why more and more farmers and conservationists look to Caterpillar Diesel Tractors and equipment for big scale operations and more profits.

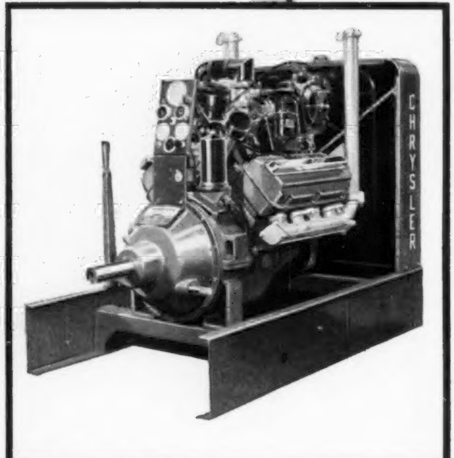
Caterpillar Tractor Co., Peoria, Illinois, U.S.A.

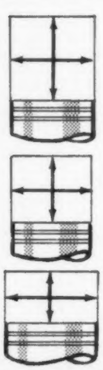
CATERPILLAR*

TRACK-TYPE TRACTORS
FROM 38 TO 260 DBHP


DURKEE-ATWOOD's Little Professor reports . . .
"Sugarbeets...1000's of 'em...
harvested automatically with
BLACKWELDER'S amazing
MARBEET HARVESTER...
for as little as 45¢ per ton!"
One man . . .
harvests 3 to 5 acres per day . . .
delivering up to 100 tons . . .
of clean topped beets!
The MARBEET Sugarbeet Harvester uses DURKEE-ATWOOD V-belts!
Blackwelder engineers saved beet farmers plenty of money when they designed the MARBEET. Now in use across the U.S. and abroad, this rugged machinery harvests all the beets, large and small, and delivers them clean. The MARBEET's unique power transmission and take-off network calls for top-flight performance. That's why Blackwelder engineers called on Durkee-Atwood for assistance in designing the rugged but gentle, foolproof and efficient transmission system. And that's why the MARBEET uses tough, long-lasting Durkee-Atwood V-belts exclusively . . . to keep beet harvesting costs low . . . even under wet and adverse conditions. Call on D-A . . . let Durkee-Atwood V-belt engineers help you with tough transmission problems.
Blackwelder Engineers also use Durkee-Atwood V-belts for this completely portable Schmidt Ditch Pump
High efficiency at low maintenance cost is achieved in this completely portable self-contained unit through the use of Durkee-Atwood Multiple V-belts. One man can set up the pump in 5 minutes anywhere, ready to deliver up to 3200 G.P.M. from depths varying from 3 to 9 feet. Another example of how Durkee-Atwood V-belts help deliver peak performance. Let D-A engineers help you with your transmission design.
ATTENTION AG. ENGINEERS—
Get your FREE copy of "Handy Tips on V-belts and V-belt drives"
INDUSTRIAL V-BELTS
See your D-A distributor or write Dept. AG-11 for catalog that includes conversion tables, engineering data, latest Rubber Manufacturers Association horsepower ratings, drive selections and helpful Do's and Don'ts of V-belt operation.
DURKEE ATWOOD V-BELTS
DURKEE-ATWOOD
COMPANY
• Minneapolis 13, Minnesota

An Open Letter to the Farmer About to Power (or Repower) an Irrigation System:





Your irrigation system is an investment that can earn you big returns. You've satisfied yourself on that score. Therefore, you've planned carefully. Chances are you've been over your requirements a good many times with the county agent and your equipment dealer. Every factor has been thoughtfully considered and laid out.

Now that it's time to select the power for your irrigation system, don't make the mistake of installing a second rate engine. Pumping water for irrigation is a rugged, continuous operation. It requires a heavy-duty industrial engine (not a passenger car engine), an engine that is factory-designed, factory-built and factory-equipped for irrigation service.

For fifteen years Chrysler Industrial Engines have been the number one engine for irrigation in the Southwest where high-capacity deepwell turbine pumping came into its own. Chrysler Industrial Engines met the requirements with heavy-duty, forged steel, induction-hardened crankshafts with Chrysler-exclusive undercut fillets for extra strength, tri-metal crankshaft bearings, extra-hard stellite valve faces and valve seat inserts, positive-rotation exhaust valves, twin concentric stainless steel valve springs, dirt and moisture-proof electrical system.

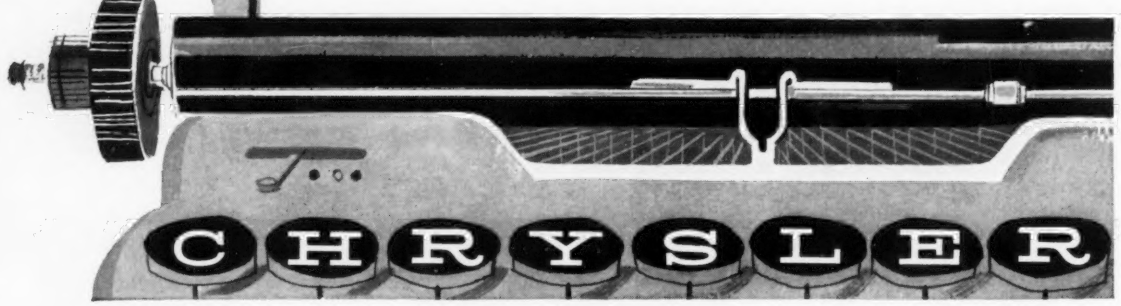
Today's Chrysler Industrial Engines are even finer irrigation engines. In the first place they are what the engineers call "over-square, short-stroke design" engines. (See drawing at left.) With this construction, piston travel is less than half of that in some competitive engines. Piston speed is proportionately low, thereby reducing bearing loads and increasing engine efficiency.

After you've carefully estimated your irrigation requirements – don't underestimate your irrigation power requirements. Allow for future expansion too. Remember: *Optimum yields result only when both power and pump meet the farmer's needs.*

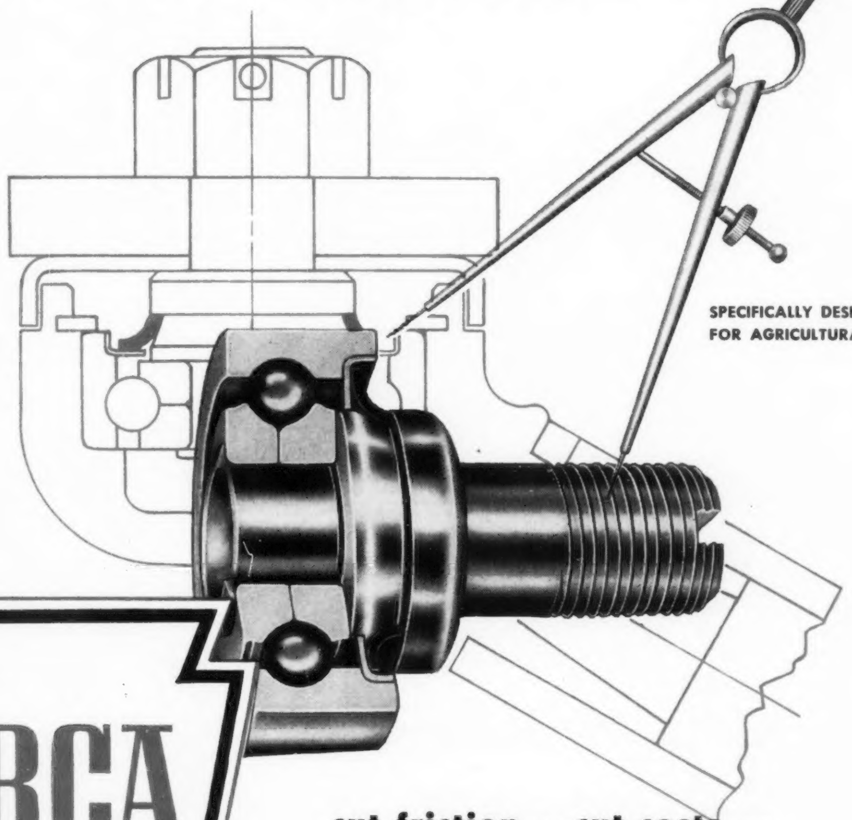
The neighboring Chrysler Industrial Engine Dealer will be glad to discuss your power requirements. He has every top-notch facility for service, too. See him or consult your irrigation equipment dealer. Or, if you prefer, write direct: ***Irrigation Engines, Dept. 16A.***

Industrial Engine Division
Chrysler Corporation
Trenton, Michigan

HORSEPOWER WITH A PEDIGREE



package unit
hay rake bearings...



SPECIFICALLY DESIGNED
FOR AGRICULTURAL SERVICE

BCA

cut friction...cut costs...
cut installation time

As roller bar side-delivery rakes increase in popularity, farm implement manufacturers have been quick to recognize the advantages of BCA *package unit* Hay Rake Bearings. Design efficiency, ease of installation, and low cost, explain why these lubricated-for-life, triple-sealed ball bearing units have been written into so many specifications.

BCA *package unit* ball bearings have been thoroughly implement-proved in all kinds of weather, under all soil conditions. If you have a bearing problem, BCA design assistance and engineering cooperation will help you find the solution.

BCA

BEARINGS COMPANY OF AMERICA
DIVISION OF FEDERAL-MOGUL-BOWER BEARINGS, INC.
LANCASTER • PENNSYLVANIA

Pioneers of pre-lubricated *package unit* ball bearings for agriculture

AGRICULTURAL ENGINEERING

VOL. 37 NOVEMBER, 1956 No. 11

Plastic Films in Farm Applications

C. E. Staff
Affiliate ASAE

Plastic films show broad flexibility in farm applications and many tests favor cost-performance advantages over permanent-type construction materials

ALTHOUGH plastic films have been used on farms for several years, recent increases in rate of consumption suggests that the volume will continue to expand in the future. Since many of the future applications will be developed by agricultural engineers, this discussion provides some basic information on plastic films, some current uses in construction, and some experimental work aimed at promoting farm applications of these materials. These experiments are expected to develop new uses for plastic films which will enable the farmer to lower his costs and gain a greater return on his investments.

The family of plastics is broad and selection of materials within a class must be made as carefully as specific metals are selected for alloying purposes. In this discussion only applications for polyethylene and vinyl films will be considered because these plastics are used most extensively as films and are expected to have widest use in agriculture. Physical properties of typical representatives of these two materials are given in Table 1. It is possible to vary the properties of vinyl films by changing the quantity and kind of plasticizer—since these are composed essentially of vinyl resin and plasticizer. Variations in polyethylene are somewhat less broad because only minor additions are made to the resins. Some of the new polyethylenes differ from the type in Table 1, principally in stiffness and strength.

Properties which are of most interest are tensile strength, elongation, tear strength, and water and gas permeability. Cost is, of course, always an important consideration.

Durability of these materials is of considerable importance and should receive special mention. As they are made from organic chemicals, plastic films are subject to deterioration by light and oxidation. Plasticizers for vinyl films are subject to evaporation and extraction. However, properly formulated and pigmented, films have good resistance to weathering and several years durability can be expected. Polyethylene is affected principally by ultra-violet light which catalyzes oxidation. This condition can be minimized by the incorporation of proper carbon blacks which act as ultra-violet screens and prevent oxidation.

Fabrication is important for many of the applications which will be developed in agriculture, and methods for fabrication should be mentioned. Vinyl films can be sealed either with heat, solvents or adhesives. Polyethylene, on the other hand, is practically insoluble at room temperature. It is an excellent high frequency insulator, and therefore has to be sealed by heat conduction. New methods for fabricating and sealing polyethylene are under development.

TABLE 1. PROPERTIES OF TYPICAL PLASTIC FILMS

	Polyethylene film DFDA-4104 black 35 1.5 mil flat die extruded		Plasticized Vinyl chloride film KRENE KDA-2265 olive 25 calendered
Specific gravity, 23°/23°	0.93		1.25
	MD*	TD†	
Tensile strength, psi, 23°	2090	1340	2400
Elongation, %	335	470	330
Tear strength, gm/mil	150	140	70
Stiffness psi, 23°	22,600		700
Stiffness, psi, 0°	50,800		4700
Outdoor durability	clear-poor black-excellent		clear-fair opaque-good
Cost, wholesale/sq ft/mil thickness	¼ cent		⅓ cent

*MD—Machine Direction
†TD—Transverse Direction

Paper presented at the annual meeting of the American Society of Agricultural Engineers at Roanoke, Va., 1956, on a program arranged by the Farm Structures Division.

The author—C. E. STAFF—is assistant to the vice-president in charge of new products and processes, Bakelite Co., A Division of Union Carbide and Carbon Corp., 30 E. 42nd St., New York 17, N. Y.

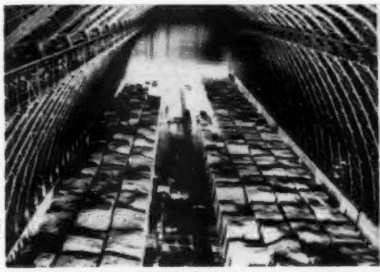
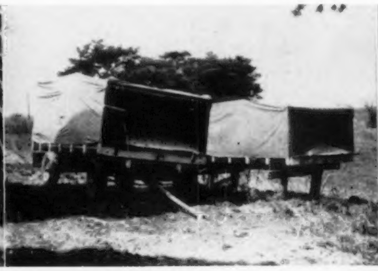




Fig. 1 *(Left)* Polyethylene films used to cover large stacks of rice to protect it from moisture in a building with a leaky roof • Fig. 2 *(Center)* Vinyl covers are finding increased applications as machinery covers • Fig. 3 *(Right)* Polyethylene used to blanket methyl bromide for soil fumigation

Fig. 4 *(Above)* Plastic silos reduce silage losses and preserve digestible nutriment and palatibility of feeds

Fig. 5 *(Right)* Silo bags, made to the diameter of a vertical silo, reduce top spoilage

While many of the applications being mentioned are not, strictly speaking, farm applications, they are presented as examples of how these films have been utilized successfully in other fields.

Tarpaulins and Covers

Recently plastic films have been used on farms as covers for protection from weather. These films are inexpensive and if properly handled, can be used for a number of years since they are not attacked by micro-organisms which cause rotting. Some vinyl film has been used for this application but polyethylene is most often used. Fig. 1 illustrates the use of polyethylene to cover large stacks of rice to protect it from moisture in a building with a leaky roof and also to serve as an insect fumigation cover. Vinyl covers are finding increasing use for applications such as machinery covers as illustrated by the wagon cover in Fig. 2.

Fumigation of fields has also become a very important application for polyethylene film and this is illustrated in Fig. 3. These films have low permeability to methyl bromide, which is commonly used for soil fumigation. Acting as a sort of blanket, they reduce the quantity of fumigant required, and the light weight of the films simplifies their use. These films can be reused until they become mechanically damaged.

For some applications, especially with vinyl films, reinforcements of nylon or glass cloth are used. This application is rather new and agricultural uses have not yet developed. However, the durability of these covers is illustrated by their use in trailer truck covers and for covering baseball fields in inclement weather. With proper reinforcement, these materials can have strength as high as 400 lb per lineal inch. It is expected that materials of this type will find uses as covers on farms.

Silage Covers

The use of plastic films for covering silage has been investigated by a number of institutions. All have reported that the quality of silage is much improved and spoilage reduced when proper care to obtain an airtight enclosure is made. The application is directed principally toward preserving silage in low-cost trench or bunker silos. In order to aid in keeping the silage airtight, straw, weeds, or other materials frequently are placed on top of the plastic cover to weigh it so that it will not be disturbed by the wind. Fig. 6 shows graphically the results of some work at Mississippi Agricultural Experimental Station(1)* and indicates the value of using plastic films, weighted with sawdust, in comparison with other materials for preserving silage.

Because of the difficulty of making trench covers airtight, M. A. Sprague(2) used a different approach. His technique has been to use large plastic bags with the capacity of 50 to 75 tons. These bags, which are formed from large diameter plastic tubing tucked under at the bottom and closed at the top after filling, have been found to produce very low losses. Digestible nutriment losses of the order of 3 to 5 percent have been measured, compared to the estimated 10 to 50 percent for vertical and trench silos. Palatibility has been excellent and the test animals have relished the fodder.

Initial cost of these containers may seem high, but if one considers the various costs involved in preparing silage as has been done by A. T. Hendrix (3), the costs are well in line with other methods of storage preservation, principally because of the high quality obtained. In addition, the plastic

*Numbers in parentheses refer to the appended references.

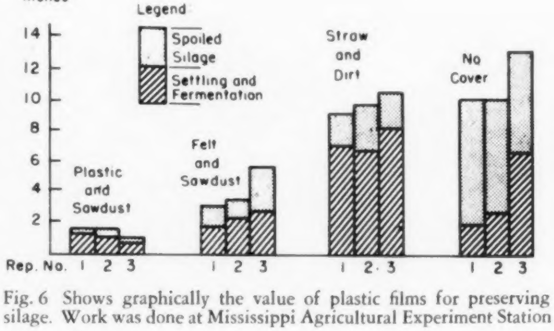


Fig. 6 Shows graphically the value of plastic films for preserving silage. Work was done at Mississippi Agricultural Experiment Station

Fig. 7 *(Left)* Plastic line irrigation canals provide low-cost prevention of seepage • Fig. 8 *(Right)* Plastic dams do not absorb moisture and soil does not stick to them

bags give much greater flexibility in the location of the silage container. With them a farmer can erect a silo where he wishes. Fig. 4.

A somewhat similar plastic cover has also been developed for minimizing the silage spoilage in vertical silos. It has been found that by using a shallow silo bag made to the diameter of the vertical silo (Fig. 5), the top spoilage can be prevented completely. Several tons of spoilage are often found in the top of a vertical silo. Eliminating this spoilage frequently can save the cost of the plastic in less than one season.

Irrigation Canal Linings

In irrigation canals (Fig. 7), the biggest problem is to prevent seepage. It has been reported that between one-third and one-half of the water which is available for irrigation purposes is lost by seepage. The properties of vinyl and polyethylene plastic films make them suitable for irrigation canal lining in that, when they are properly compounded, they are resistant to sunlight, impervious to water, and inert to soil organisms.

In their application, caution must be taken to avoid puncture either in installation or in use since relatively thin films will be used. V. H. Scott(4) reported that six-mil polyethylene film reduced the seepage on test installations by 96 percent compared to the control whereas asphaltic membranes reduced this seepage only by 35-75 percent.

Studies of films for canal and pond liners at the Utah Agricultural Experiment Station by C. W. Lauritzen (5) indicate complete prevention of seepage. The economics of lining irrigation ditches with film or other materials is difficult to evaluate as the value of water depends considerably upon its availability and intended use. An indirect value of lining canals is that of reducing the damage to the lower lands which are frequently rendered unproductive by the seepage of water. This is often a more important factor than the value of the water which is saved by lining. Information has been published (6) reporting that, in Texas, canals with an infiltration rate of about 2 cu ft per sq ft per day could produce additional income of 22¢ to $1.10 per lineal foot if the seepage were prevented and the water made available for plant growth. It is anticipated that the use in this application will develop as more agricultural engineers become acquainted with it and as improved techniques for making the installations are developed.

The durability of plastic films for this use will not approach that of concrete, but it is believed that the annual cost of using films will be more favorable. For some applications, films of several mil thickness will be used, but on individual farms where it is desired to remake the canals after preparing the whole field, it is possible that even 1½ or 2-mil films will be used on an annual basis. Films of this thickness can be laid easily under most conditions and can be expected to perform satisfactorily for one season, except for minor mechanical damage from animals and other sources.

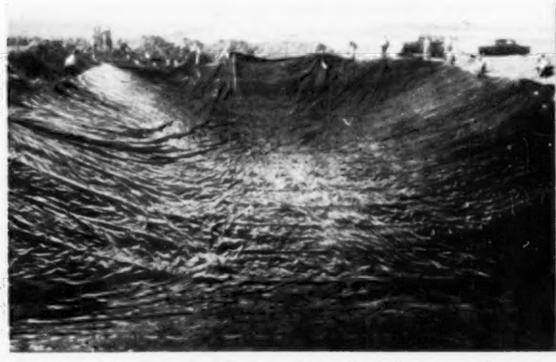


Fig. 9 *(Left)* Recent installation of a polyethylene pond liner in Canada • Fig. 10 *(Right)* Completed installation of a Krene pond liner in South Carolina

Fig. 11 *(Left)* Dried out wooden storage tank restored to use with plastic tank liner • Fig. 12 *(Right)* Polyethylene film provides excellent mulch for strawberries and prevents ground rot

Plastic dams (Fig. 8) have been used for a number of years to regulate the flow of water in irrigation ditches. The plastic films, which are generally vinyl, are easy to handle and shape, do not absorb moisture and the soil does not stick to them.

Pond liners

In addition to Lauritzen's work in Utah, the U.S. Department of Agriculture recently has investigated the use of plastic pond liners for preventing seepage from farm ponds and reservoirs, in the eastern states, particularly South Carolina and Virginia, where the problem of providing an impervious bottom is acute. Some installations have also been made in Canada where water from spring runoff must be saved for household use during the entire year.

The technique which has been used for the lining of ponds has employed a prefabricated piece of the approximate dimensions of the pond which has been inserted in a prepared excavation. The liners have all been accordion-folded in both directions so that the installation is relatively simple. Fig. 9 shows an installation, of a polyethylene liner made recently in Canada. Before installation of the pond liner, the bottom has been raked to remove any sharp objects which might puncture the films and the sides dug to a slope of 3 to 1. It has been determined in Utah that a 3 to 1 slope is necessary for maintaining backfill on these films.

After bottom preparation, the liner has been unfolded in one direction. Then with assistance from several persons, the liner has been unfolded in the other directions so as to cover the full bottom of the pond. The edge of the liner has been buried in a furrow dug around the periphery of the pond slightly above the water level. Some installations have been left uncovered but generally it is believed preferable to backfill a few inches with soil to prevent mechanical damage to the film from animals or from objects which are thrown into the pond. It has been found that where the backfilled material has some aggregate, it is preferable to do this backfilling operation after water has been placed in the liner so that some of the energy of the falling aggregate is absorbed by the water.

This method of reducing pond seepage or for permitting ponds to be built where the soil is highly permeable can be very important for providing water savings in critical areas. The various installations will be watched carefully for their performance so that the economics of this type of installation can be evaluated. Another installation of a Krene liner made in Clemson, S. C. is shown in Fig. 10.

Tank Liners

On a smaller scale than pond liners, films have also been used to line tanks and cisterns. In some areas dug wells are quite common but, with the dropping of the water table, they are no longer productive. These can be converted into cisterns quite easily by the insertion of a plastic film liner.

Plastic films have also been used for lining leaky water tanks, such as concrete tanks or dried-out wooden storage tanks as shown in Fig. 11.

Mulches

Another method of water conservation is the use of films for the mulching of row crops. Because the impermeability of plastic films to water and water vapor is an outstanding property, experimental work has been conducted on the use of films for preventing evaporation of moisture from soil. The moisture that is saved is made available for plant growth.

Polyethylene film in the thickness of 1½ mil is principally used for this mulching application. Experiments are underway with clear, black, white, and aluminum pigmented films to determine which is most satisfactory. Preliminary results indicate that the optimum color desired varies with the planting season and possibly with the latitude.

Some of the early work along this line was with the mulching of strawberries in the Los Angeles area as is shown in Fig. 12. In this application, the film was used principally to prevent ground rot which was responsible for spoiling about one-half the strawberries. By laying film under the berry plants, they were kept from contact with the ground. Spoilage which would ordinarily ensue from such contact was prevented. This use has already been developed into a large application even though the technique has only recently been publicized. Improvement in growth is also obtained by the prevention of evaporation from the soil. It is found that in some of these fields that the crop yields were doubled by the use of film.

In most mulching experiments, opaque films have been superior to clear films since, in addition to controlling mois-

ture and thereby reducing or eliminating the irrigation requirements, the opaque films prevent the growth of weeds. Experiments in Kentucky(7), Mississippi, and Oregon(8) have indicated that crop yields can be increased 50 percent or more by the use of mulches on tomatoes, beans, melons and other crops. The saving in weeding cost alone is reported to be sufficient to pay for the cost of the film. Experiments on this technique are underway at a number of other locations and it is considered an important method for increasing our food production at low cost.

Floor Moisture Vapor Barrier

In the construction field(9) polyethylene film is being used under concrete slabs to prevent moisture from permeating through concrete which, as is generally known, is quite permeable to moisture vapor. A polyethylene film laid under concrete, as shown in Fig. 13, has been found satisfactory for reducing this diffusion. The technique is being used extensively under basements and floor slabs of homes, hospitals, and factory buildings. It should be of interest to farmers in the construction of their buildings as a means of reducing high humidity conditions.

Concrete Curing

On the upper surface of cast concrete, a polyethylene moisture vapor barrier is being found useful as a curing aid. The application of a light polyethylene film over concrete during the curing stages has been approved by several state highway departments as a method for maintaining the desired water content in concrete so that an optimum cure is obtained. For this purpose, a white polyethylene film with a high reflectivity is specified by most states. This technique provides denser, harder concrete which should give superior service in barns, barn yards and other areas.

Wall Moisture Barrier

An increasing quantity of polyethylene film is being used as a wall moisture vapor barrier for home construction since its impermeability is far superior to that of conventional roofing papers. With the increase in tightness of construction of houses and the desire for humidity control, this technique, as shown in Fig. 14, is becoming important. The moisture vapor barrier should be installed on the inside of the studding rather than the outside so that moisture will not condense in the core space between the inner and outer walls.

This use of film should be applicable in many farm structures since considerable rotting of wooden members due to high humidity in buildings with fairly tight outer walls is reported.

Greenhouses

An interesting use of plastic film is in the construction of plastic-covered greenhouses. These, it is believed, can indicate a new method for providing low-cost buildings suitable for many farm purposes. (Fig. 15). Such greenhouses have been constructed at University of Kentucky(10), Purdue University (11) and in California(12) as typical examples. The film is attached directly to rafters and secured by nailed lath.

The reasons for covering greenhouses with plastic film are: low cost, sufficient durability and light transmission. In most places 2-mil polyethylene film is used, sometimes with a second inner film of 1½-mil thickness. The clear polyethylene which is used, is subject to oxidation under the influence of ultra-violet light and has to be replaced annually. But the cost for such replacement is considerably lower than the annual charges applicable to the conventional greenhouse.

In southern states, it is usual to use only a single thickness of film, but in the northern states it is desirable to use a double thickness to provide the insulation of a stationary air layer. The use of the stationary air has decreased heat losses by 50 percent or more and the saving in heating charges compared to a glass house is generally sufficient to pay for the annual film replacement cost. It has been found that increased ventilating facilities are required since the houses are so much tighter than the conventional glass houses. The carbon dioxide retention in the plastic houses is superior and increase in plant growth has been attributed to this.

Although most polyethylene films are slightly hazy, this does not reduce the light transmission and it has been found that growth is just as satisfactory or superior to that in glass houses. In addition, it has been found that the plastic greenhouses will actually take more abuse from the elements than their glass counterparts. Hail, for instance, bounces off the plastic films; houses have gone through winds of 80 mph even when their films have been partially oxidized. Some small houses being used at the time for some experimental work by the U. S. Department of Agriculture at Norfolk, Va., were demolished by a tornado but the film was found to be damaged only where the broken rafters penetrated it.

In the San Francisco area a slightly different technique for greenhouse coverings has been developed utilizing wire netting (12). In this case, a welded wire netting has been stretched on the rafters and then a layer of film applied, followed by a second layer of wire netting. The netting is

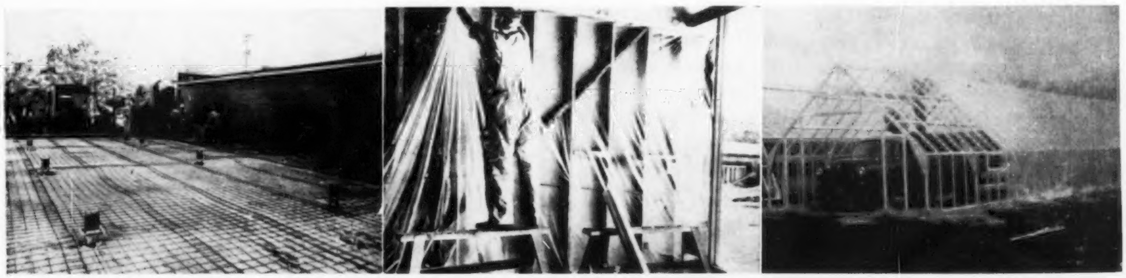


Fig. 13 *(Left)* Polyethylene film placed under concrete slabs prevents moisture from permeating through concrete • Fig. 14 *(Center)* Film provides wall moisture vapor barrier for home construction • Fig. 15 *(Right)* Plastic-covered greenhouses provide low-cost construction with suitable durability and light transmission

used to give extra support to the film and will permit increasing the span between rafters.

The success of thinner gage film for the greenhouse application is due to the elasticity of the film, its strength, and the means of fastening the film to the rafters. The film has generally been fastened by means of a lath or nailer the length of the rafter so that the stresses which are developed in the film are distributed over the length of the rafter rather than around the nails. It is of interest to calculate from the stress-strain diagram of polyethylene, the stress which film can take in this application. If a film is stretching so that the cord becomes an arc of a circle whose angle is 60 deg, the strain produced will be 4.7 percent which is well within the recoverable elasticity of polyethylene film. In order to create this strain in polyethylene film, it is necessary to apply a wind force of 12 lb per sq ft on a 2-mil film on 2-ft centers, which is equivalent to a wind pressure of 70 mph. Polyethylene film actually has greater extensibility than 4.7 percent and so a greater wind load can be tolerated.

Other Farm Buildings

The elasticity and low cost of plastic films should permit their use in many other types of farm buildings besides greenhouses. There has been some interest in the possibility of enclosing chicken houses in plastic films to provide a wind break during the winter months, the houses normally being left open all summer. It is suggested that 1½ or 2-mil polyethylene film held in place by laths be applied for this purpose on an annual-use basis since polyethylene film is so economical it can be replaced each year. For the construction of other buildings such as machinery sheds, cattle shelters, and barns, where more permanence is desired, it is suggested that heavier film such as 8-mil black polyethylene film be used. This can be installed directly over the rafters which could be spaced up to 6 ft apart so as to minimize the cost of the frame. If desired, wire netting could also be used for buildings of this type. Black polyethylene film is expected to have an outdoor durability of 10-15 years in this thickness except for mechanical damage from falling branches, etc. Since black film has a high heat absorption coefficient, for some applications an opaque white film laminated to black film may be used for buildings of this type. It is anticipated that further experimental work along this line will be undertaken soon because of the possibilities of decreasing the cost of farm buildings.

These are a few of the applications which are currently being made and are planned for use of plastic films in farm construction. The durability of the films combined with strength, elongation, moisture and gas impermeability, and relatively low cost will, no doubt, encourage agricultural engineers to find new applications for these materials. The use of these materials on the farm should result in lower cost of operation, and thus allow the farmer to operate more profitably.

References

1 Owen, J. R. and Miles J. T. Mississippi State College Information Sheet 524.

2 Sprague, M. A. What's New in Crops and Soils, October, 1955, vol. 8, no. 1.

3 Hendrix, A. T. Presented before Southern Agricultural Workers, Atlanta, 1956.

4 Scott V. H. Prefabricated linings for irrigated ditches, AGRICULTURAL ENGINEERING 37, p. 113-116, February, 1956.

5 Lauritzen, C. W., Haws, F. W. and Humpherys, A. S. Plastic films for controlling seepage losses in farm reservoirs, Utah State College Bulletin 391, July, 1956.

6 Bourns, C. T. Seepage losses from irrigation ditches on the south plains of Texas, Texas Technological College, Lubbock, February, 1955.

7 Emmert, E. M. *Kentucky Farm and Home Science*—winter issue, 1955.

8 Clarkson, V. A. *Oregon's Agricultural Progress* — spring issue, 1956.

9 Thor, C. J. B. Building research institute, plastic study group, University of Michigan, November 1955.

10 Emmert, E. M. *Market Growers Journal*, February 1955, p. 22—*American Fruit Grower*, February 1955 p. 37

11 Thomas, M. O. Purdue Extension Bulletin 411—"Vegetable Production in Plastic Greenhouses."

12 Kofranek, A. M. and Kohl, H. C. *Florist Review 1955 — Florist Exchange and Horticultural Trade*, p. 15, January, 1955.

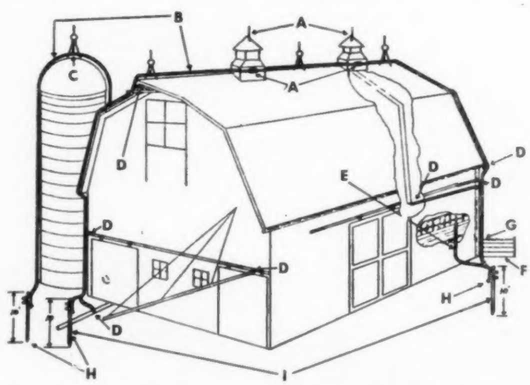
13 Handbook of Engineering Fundamentals — Eshbach First Edition 1936—p. 9-65.

Linking Metal Parts for Lightning Protection

MODERN lightning protection not only intercepts lightning bolts but is designed to leak lightning to the sky, according to a report from Security Mfg. and Contracting Co., Burlington, Wis. This means collecting static electricity from all the metal parts in farm buildings. As farms use additional electrical equipment as well as more metallic components in farm buildings, the lightning hazard is said to increase steadily.

An interconnected lightning protection system consists of *(a)* an interconnected system of aerial points and *(b)* a lightning arrester system for protection within the building against induced or secondary lightning. Ground electrical charges run through buried ground rods, metallic building parts, and conducting lines upward to aerial points and are leaked little by little to the air. In this way lightning bolts, which actually strike from the ground to the sky, reportedly do not concentrate enough potential to damage structures.

The capacitor-type surge arrester does not work as an electrical safety valve, but as a bypass for high-frequency current while blocking the 60-cycle power. Linked to the electrical system of farm buildings, it protects against powerful surges of current induced during electrical storms.



(A) Lightning conductor runs around ventilators and a lightning rod is mounted for each ventilator; *(B)* Conductor line is not run into roof valleys; *(C)* Separate point for silo with conductor connected to main down conductor; *(D)* To prevent side flash, tracks, rain gutters, and plumbing are interconnected with the conductor cable; *(E)* Stanchions and other metal parts are interconnected; *(F)* Wire fences are interconnected to the system; *(G)* Conductor line should be protected up to a height of 6 or 8 ft; *(H)* Ground conductors should be in moist earth 2 ft from the building and driven 10 ft down; *(I)* Down conductors are kept as far apart as possible.

Management Engineering in Agriculture

Harold E. Pinches
Fellow ASAE

Integration of processes, machines, structures, and forms of product into balanced and efficient systems is an important phase of management engineering. The author suggests that an important segment of agricultural engineering research should be devoted explicitly to application of the methods of systems engineering to farm operations

EVERY farmer is managing an enterprise which ties together, inside the fences of his farm, a variety of dissimilar activities. What the farmer must do, in interrelating these varied farm operations and implementing his managerial judgments, is a comparatively unrecognized area susceptible of professional engineering development. The task here, and the opportunity, is the development of *management engineering of farm practices*. Essentially the same meaning may be stated in other words as *agricultural systems engineering*. For the purposes of this discussion, these terms are used interchangeably.

"Management" engineering, or "systems" engineering, should be distinguished from what might be called "development" engineering. A development, or design, engineer is concerned with invention or refinement of design of specific machines, structures, or unit operations. His is the work which may, and properly does, become more and more specialized and, thereby, he becomes an expert in a specific field. The essential difference between management engineering and development engineering is to be found in attitude or purpose. It is the difference between applying engineering training and facilites to problems of *organization* or of *design*.

The function of the systems engineer in agriculture would be much like industrial engineering in purpose and approach, although necessarily different in practice and mode of application. Systems engineering in agriculture should start with analysis of farm operations or processes, and proceed through work flow, or process layout, to implementation and farm layout.

Management engineering of farm practices would examine critically the total operations of a farm – or any given segment of operations – as an interrelated and *interacting* series of processes. It would seek to discover which of these processes, or of the resources being put into them, is a limiting or determining factor for all the others. A major purpose would be the elaboration of better-balanced operations, through discovery of "bottlenecks," improper sequences, poor timing, or processes that could be eliminated. In an industrial plant, this would be the responsibility of industrial engineers concerned with the tooling, materials-handling equipment, structural facilities, and job specifications which, all together and in constant interaction, determine the capacity and productive efficiency of the plant.

On a farm, the approach would be similar. Agricultural systems engineers would seek to bring the farm's resources of soil and water, machinery, structures, livestock, and labor into a condition of better operational balance. Such an integrated approach would challenge the technological validity and biological necessity of every operation. It would evaluate critically the type, scale, timing, sequence, nature, and purpose of every element of every process. For example, each of the operations of tillage would be examined in relation to the whole process of tillage; planting practices would be studied in relation to harvest; transport equipment and methods in relation to harvest operations, farmstead storage, materials handling and processing.

It is timely that many agricultural engineers are concerned with compaction and other damages to soil structure that too frequently accompany tillage. The whole concept of soil preparation in relation to plant growth and control of water needs overhauling. Ordinary tillage operations throughout much of this country involve plowing, disk harrowing two or more times, and spike-tooth harrowing, or some other final operations, before planting. Agricultural engineers have spent a vast amount of time, energy, money, and other resources on improving the individual machines and their performance on those several operations. But, with what results? Tillage, in producing what is generally regarded as a good seedbed, also produces conditions conducive to erosion, reduced infiltration of water, and enhanced weed growth.

This whole complex must be considered, from the time the plow enters the ground until lay-by of the crop, as a series of interacting operations. Appropriate consideration of the determinant factors may permit changes which will result in better soil structure, better infiltration of water, less erosion, fewer weeds, lower costs, and improved average yields.

The determinant factors, in this case, are germination of the planted seeds and emergence of the seedlings. For these processes, it is not necessary to make a seedbed of the whole field; that is only a practice continued without serious question from the days of limited-duty animal-powered implements. Recent research findings suggest that machines should be developed which would prepare seedbed conditions only in narrow strips in which the seeds would be planted. All of the field area between the planting strips would remain rough and, thereby, highly permeable to water and air and resistant to erosion. Moreover, two or three tillage operations would be eliminated. The coarse texture of the upper layer of soil generally would be hostile to germination of weed seeds, and would reduce the need for cultivation, whether for weed control or to break soil crusts.

Favorable results have been obtained in enough widely-separated places and over enough years to justify prediction that modifications of the so-called "plow plant" method will be found suitable for a number of crops over wide areas. Some details of methods and the best forms of

Paper presented at a meeting of the North Atlantic Section of the American Society of Agricultural Engineers at Cornell University, Ithaca, N. Y., August, 1956.

The author—HAROLD E. PINCHES—is assistant director, Farm and Land Management Research, ARS, U.S. Department of Agriculture.

adapted planting machines have still to be worked out. New types of planters may be necessary, possibly including planters in which power is applied directly to the soil immediately in front of the planter shoe. But the important point to be noted here is this: An improved system is being substituted for a conventional sequence of operations, through analyzing and modifying practices around the determinants, and then following through on beneficial changes throughout the sequence of interrelated operations.

Management Engineering Calls for Team Work

An engineer concerned with the integration and balancing of systems will be involved in economic relationships. The necessity for economic evaluations, as well as physical judgments, means that the management engineer should be alert to and responsive to economic judgments by others and, preferably, reasonably well trained himself in agricultural economics.

Similarly, the management engineer generally will have to make or seek more judgments and evaluations in terms of biological relations than will a design specialist. He needs to be alert to and responsive to judgments by others in terms of biological relations and, preferably, more broadly trained in the biological sciences than most agricultural engineers.

Since it is practically impossible for one man to be a good engineer, a competent economist, and a well-trained agricultural biologist, management engineering calls for more team work than is usually found in conventional research. The "task force" approach will often be required.

The nature and scope of many research projects are such that they do not extend beyond the normal bounds of a single subject-matter field. Other problems may be so complex that progress seems possible only by tackling separately pieces of the problem. And, of course, limitations of funds or research personnel often seem to preclude any other course. However, the piecemeal approach—especially, when labeled and confined within one of the conventional divisions of farm machinery, farm structures, rural electrification, and so on — is due partly to administrative and professional attitudes. But attitudes and purposes can be changed. There is need in our profession to learn how to consistently cross-fertilize our traditional subject-matter divisions. A major problem for agricultural engineering is to learn how to use more frequently an integrated team, or task force, approach in research.

The task force has a place, however, for the specialist. Indeed, it may give the design specialist opportunity to perform as a specialist beyond what more isolated, individualized research projects can afford. Management engineering, properly developed as a methodology of research, should provide new viewpoints, new bases for judgments on what should be done in design.

Adaptation of Industry's Methods

Superficially, it is not so easy to organize or apply management engineering in agriculture as in industry, since there is not the same opportunity on a farm to set up a management engineering staff and research facilities as in a medium- to large-sized manufacturing company.

Two pictures seen recently may illustrate the superficial differences between industrial and agricultural management engineering. One was a picture of a new $20-million manufacturing plant. The other picture showed several executives looking at a scale model of the new plant—a three-dimensional model laid out on a table about 10 to 12 feet square.

That model was an expensive and finely-detailed structure to aid in executive decisions. Doubtless, it was changed in part several times before taking final form. Also, no doubt, it was a projection in three-dimensional physical form of ideas and working compromises resulting from thousands of man-hours of study of layout in terms of operations, sequences of operations or work flow, adequacy of facilities, and economy of structures. It would have been folly, if not impossible, to build that $20-million plant before such detailed and analytical study.

The usefulness of that model of the new plant is apparent in the picture of the executives shown studying it. They were able there to see relationships which would be more difficult to see—or might always escape attention—in the daily activity and limited visibility at most points in the full-scale working plant.

A scale of 1 ft : ¼ in permits layout of a 600-ft plant on a 12-ft table. Other scales may be used, but even with nothing larger than this scale, it is possible to spot and see distinctly every item of consequence that will be larger than 2-ft square in the finished plant. That scale would certainly accommodate everything of significance on a farm — even a scale symbol for a 3-legged milking stool!

Why, it may be asked, has not comparable and similar study been devoted to the layout of farms and to the interrelationships of farming operations? It is seemingly not so easy to do, because farms are dispersed in comparatively small, superficially different units. Also, there is no central management group at one place comparable to the few top executives responsible for the final decisions on an industrial plant. Then, too, because millions of dollars are to be spent within a few months for construction and equipping of a factory, all parts of which must work together effectively and efficiently at all times, a large amount of careful planning by industrial engineers seems logical and essential and is provided for without question. But is not a comparable procedure equally imperative for farms?

Within a 75-mile radius in many areas of the United States there are 1,000 farms very much alike in essentials, say 1- to 2-man dairy farms, with production buildings averaging at least $10,000 and machinery and equipment another $10,000 per farm. Not counting value of land and cattle, they constitute a $20-million plant! And that "plant" has a total working force of 1,500 or more men, or probably a greater number than a $20-million industrial factory.

Now consider how much less analytical study and planning for integrated, efficient, lowest-cost operation — comparable to the type of management engineering planning for a $20-million factory — have gone into just this one $20-million farm plant. Further, let it be recognized, there are doubtless several other multi-million-dollar "farm plants" within this same 75-mile radius.

It is the existence of large numbers of farms essentially alike within relatively small areas that provides opportunities for research in agricultural systems engineering. While few farms are large enough to afford management engineering specifically for the individual unit, it can be justified by many groups of farms. The elements of similarity, which permit us to speak of "typical" farms, form the solid base on which research could be conducted. The processes, prac-

tices, and facilities of *typical farms* could be investigated in *prototype*.

Most systems engineering problems will probably need to be brought into focus by studying prototype farms. But consideration, in principle, of the nature of farm work encourages the belief that management engineering research is just as applicable, and likely would be as fruitful, in agriculture as in industry. Systems engineering may be applied wherever one or more of certain situations exists. These situations are *(a)* materials being handled, *(b)* materials being processed, *(c)* environmental conditions being controlled. In agriculture, a fourth situation may be added: *(d)* animals being handled. Nearly all farm work falls within one or another of these activities.

Materials Handling

A very large part of farm work is materials handling, i.e., changing the location or position of some material. Considering the volume and weight of materials handled yearly on American farms, nothing deserves more serious interest. Some of the major tonnages are, in round numbers: hay, 100 million tons; corn, 100 million tons; milk, 60 million tons; commercial vegetables, 18 million tons; potatoes and sweet potatoes, 11 million tons; seed cotton, 10 million tons; eggs, 3 to 4 million tons; tobacco, 1 million tons (which, of course, was several million tons before drying). In addition to farm products, there are other materials such as fertilizers, sprays, seeds, purchased feeds, and so on, which American farmers handle also in large tonnages.

Great ingenuity and a vast amount of experimentation have produced reasonably efficient field machines for harvesting numerous crops. These machines are used in the great rush to harvest tremendous tonnages of crops which are hurried into storages that are, too frequently, only overgrown boxes to hold the crop products out of the weather. From then on these tonnages are moved – often several times – essentially by hand or, at best, with equipment that requires too much labor.

To be suitable for mechanical handling, agricultural materials must be made easy to handle. Those which flow readily at any angle steeper than some characteristic angle of repose are relatively easy to handle. Therefore, one obvious direction of investigation with other materials is to attempt to change them into fluid or granular forms. By shelling corn, for example, it will flow in a way that ear corn will not do. Chopped hay is not, of course, either fluid or granular, but it is in a form capable of transport in a fluid (air) or of transport similar to granular materials by a variety of mechanical conveyors.

If a material cannot be broken down into a fluid or granular condition, it may be standardized dimensionally and, thereby, be made more susceptible of automatic or semiautomatic handling. Hay, when baled, is formed into large, dimensionally-similar units. While there is no universally-used set of dimensions for bales of hay, each baler makes successive bales of the same size. Thus, another condition is established which can be the basis for improved handling.

If the material itself cannot be put in form or condition to flow readily nor formed into stable bales or comparable units, it may be put into sturdy carrying containers (crates, boxes, etc.). These containers may then be palletized – either by loading them on a palletized platform, or, ideally, having the pallets integral with the box. Surely, palletized handling of much of the tonnages of materials to be lifted and moved on farms should be made possible by adaptation of farm tractors to fork-lift service.

There is much more to materials handling, however, than adaptations and installations of conveyors, push buttons, and fork-lift tractors. The basic problems are those of integration of sequences of processes, equipment, and facilities.

There are two desirable approaches to the handling of materials. One is to mechanize the handling. The other is to eliminate handling. Generally, efforts are aimed at finding ways to do the first, but it is in order to suggest that attention should be turned more consciously to seeking ways and means to cut out handlings.

To point up this contention, it is good to look back occasionally to see how we might have proceeded more directly. Consider how long it took, after the invention and widespread adoption of mechanical milkers, to come to the modern system of conveying milk by pipe direct from cow to cooler tank. In this connection, remember the 60 million tons of milk per year – 165,000 tons every day of every year. Effort was centered for many years on adapting portable-bucket mechanical milkers to stanchion barns. There were studies to determine best size and shape of bucket; single vs. dual units per bucket; vacuum line vs. electric plug-in systems; time-and-motion studies to determine the optimum number of units for one man to handle; carrying of full buckets to the milk house vs. receiving cans in screened carts in the barn; location of the milk house relative to the stanchion barn, etc.

Cows had been milked in stanchions for many years, and had been milked into buckets from time immemorial. For a long time the two simple and universal conditions which had always been available for progress failed to be recognized. First, milk, being fluid, was already in form suitable for conveying by pipe. Second, it was not necessary to carry mechanized buckets to rows of cows immobilized in stanchions. Instead, the cows could walk to specialized milking stations which, in turn, permitted development of rationalized designs for efficient working conditions and stepped-up labor efficiency while reducing fatigue.

It was certainly desirable to adapt portable mechanical milkers to existing barns. It was a boon to many thousands of farmers. However, in terms of systems engineering, we should have advanced earlier—through research on prototype farms—to development of specifications for milking parlors and direct piping from cow to cooler tank.

The lesson here, I believe, is this: Beware of ultra-refinement of existing processes. Don't work too long on what may seem to be the obvious approach. One of the major problems for agricultural engineers – perhaps more than for most types of engineers—is to avoid being drawn into concentration on solution of single present problems without working back to basic relations, whence may come better solutions by wholly new routes. Especially in efforts to improve materials handling, it is necessary to beware of involvement in gadgetry. Ultimate success will come, rather, from engineering design of integrated systems, taking fully into account the succession of all interrelated

processes, forms of the product, structures, and equipment for conveyance.

Farmstead Engineering

These advances in milking operations point the way for development of comparable advances in other aspects of dairy, poultry, and livestock farming. One of the most persistent restraints on the earnings of a dairy, livestock, or poultry farmer is the number of cows, hens, or other animal units one man can care for. It is necessary to find ways to reduce chore time and chore labor on farms. Attention has been called to the importance and urgency of this area of investigation by Byron T. Shaw, administrator, ARS, United States Department of Agriculture. Dr. Shaw has emphasized the need of hunting for ways to cut down on chore time and chore labor which he characterized as "perhaps the greatest single leak in farm costs today."

This is, fundamentally, the problem of farmstead engineering. Applications of mechanical power and energy to the operations and processes at the farmstead have lagged behind the comparable mechanization of farm field operations. The relatively slow advance of farmstead mechanization has been due to the fact that much of the work can be done by hand. Also, until the recent availability of electricity to most farms, suitable forms of power and energy have been lacking.

A very large part of these farmstead processes and operations are directly related to dairy and livestock husbandry. It is estimated that the labor requirement for livestock production in 1954 amounted to approximately 5.7 billion man-hours, or more than 38 percent of all farm work. While no division is available between "farmstead" and "field", the nature of livestock production is such that all but a small part of that staggering total of man-hours of labor is spent at or near farmsteads.

Since there is great variety in farmstead operations and processes, there must be numerous specific areas of research and of types of development for their improvement. However, most of them have some common characteristics, viz., they are repetitious, with each cycle being repeated on many days of the year; confined to relatively small areas; require some input of energy for conveying, metering, or positioning of materials, and for conditioning of materials or products for use or storage. These common characteristics make farmstead operations susceptible of "mechanization." Also, these are the characteristics which fit these operations and processes to improvement through systems engineering.

Systems Engineering Applications

A few suggestions are advanced for consideration in an attempt to answer the question, "How can systems engineering be applied in agriculture?" The first step would be to define clearly the common activities, or common physical organization problem, of farms typical of the kind of farms for which the research or engineering planning is being done. The problem should be sharpened, and the possibility of a successful solution enhanced, by holding to a rather narrow range of sizes of farms within the group. For example, the optimum system for a 20-cow dairy farm will probably not be the same as for a 60-cow farm.

Then, the management engineer should attempt to extend the projected system in prototype as far as possible both ways from his starting point. What may at first seem to be a problem solely within the farmstead may have its real cause, and, therefore, its solution out in the field. Similarly, one may have become quite efficient in field production of a form of product not well suited to subsequent farmstead processes. Attempts to extend the system should not only uncover related factors, but also engender skill in systems building.

Economic factors must, of course, be met ultimately in practice. Indeed, the primary incentive for developing a better system will usually be to establish more favorable economic relations. But in the initial stages of development, one should proceed in prototype relatively independently of economic factors in order to discover and test possibilities.

Where might these principles lead research in a process, such as, farm handling of forage? The elements of a complete system must include harvesting, preservation, storage, and feeding. It is assumed that the forage (hay) will be grown and fed on the same farm. The central or key idea, from which to work in both directions in seeking to develop a system, is that the product (forage) should be made into a form or forms suitable for mechanical conveyance which, with automatic or semiautomatic controls, would make possible self-feeding of the cows.

The storage structures would be geared to the forage-handling operations—conveyance and feeding—rather than the other way around. Structures are, apparently, the weak link in farm systems engineering, since so many farms have sturdy and expensive barns which, too frequently, are considered to be semipermanent and it is assumed, therefore, that processes have to be adapted to them. It is true, of course, that on any individual farm, adaptation to existing buildings may be necessary for years before the farmer is able to make the changes necessary for a better system. However, the underlying assumption of systems engineering research should be that the present barns may be displaced. Fire, wind, or other catastrophe may remove them. More importantly, research should be seeking how and when to supplement, remodel, dismantle, or even abandon barns which are still in good repair—just as forward-looking manufacturers refuse to be held back by obsolescent buildings when major changes or improvements of their systems, of which buildings are integral and influential parts, justify different structures.

Then, associated field operations would be geared to the storage and handling processes and facilities. In general, farm machines for field operations have been inventions of items (for unit operations) nearly independently of farmstead storage and handling. The hay fork in the high barn relieved the arduous labor of pitching hay off the wagon into the barn, but the field loader was unrelated to the hay fork. Hay elevated by the mechanical loader onto the typical flat-bed wagon could be arranged fairly well for unloading with fork or slings, only if the man on the load was skilled and would hustle fast enough. The integrating factor between the loader and the fork was the man's sweat!

The interactions between field processes, form of product, materials-handling facilities, and design of farm structures are starkly attested by hundreds of thousands of high, self-supporting barn roofs designed around the storage of long loose hay handled by grapple-forks or slings. Happily, this system is now obsolescent, but how far have we gone in developing better systems and facilities—integrated from field to cow?

(Continued on page 758)

Implements for Wind Erosion Control

N. P. Woodruff and W. S. Chepil
Assoc. Member ASAE

Tillage equipment that will prove most effective in the prevention and control of wind erosion is that which will do a good job of creating a cloddy soil surface and at the same time avoid burying the crop residue

IN his efforts to derive a livelihood from the soil, man has destroyed much of the natural vegetation and brought more and more land under cultivation. Periodic crop failures, particularly in the central and southern Great Plains regions of the United States, have produced a vegetative cover too sparse to protect the soil against high winds. Also, in many instances improper tillage practices have tended to leave the soil bare and highly pulverized.

However, progress in wind-erosion prevention and control is being made continually. Of particular importance in this connection are the development, improvement, and application of tillage implements in wind erosion control.

There are two principal groups of factors that must be considered in evaluating the requirements of tillage equipment for wind erosion control. These are *(a)* the conditions of operation with respect to climate, diversity of crops, soils, purposes of tillage, and size and method of farm operation and *(b)* the major factors influencing erodibility of field surfaces including residues, soil cloddiness, and surface roughness. Once these factors have been considered, it is possible to enumerate the various requirements of the equipment and to draw conclusions with regard to the effectiveness of present day equipment.

The Conditions of Operation

Climate. The annual precipitation on the Great Plains regions of the United States not only is low but also is extremely variable. Wind velocities are generally high and the peak velocities usually occur in years with low precipitation. The influence of the tremendous climatic variability on the conditions of operation of tillage machinery is exerted in many ways. It means that, in a year when precipitation is high, the problem will be one of handling heavy residues on wet soil, often a soil covered with small playa lakes because of poor drainage. On the other hand, during dry years the chief function of the tillage tool may be as an emergency control measure to bring up clods and roughen the surface on a soil that is extremely dry and compacted.

Diversity of Crops. Tillage machinery or a "line" of equipment must be highly versatile to meet the requirements of the various crops grown in the Plains area. These crops usually consist of wheat and sorghums; however, other crops such as cotton, beets, alfalfa, and potatoes are often grown. While wheat and sorghums can generally utilize the same implement, often a planter that places the seed in wider rows provides a better environment for sorghum crops. Cotton, alfalfa, beets, and potatoes necessarily require completely different equipment.

Soils. The chestnut and brown aridic soil groups (10)* are the principal soils of the Great Plains area. They are generally low in organic matter and usually have carbonates near the surface. The texture of the soils varies from sand to clay. It is apparent that insofar as soil conditions are concerned, tillage equipment used for wind-erosion control can be expected to operate in anything from light sands where traction is a problem to heavy clays where power becomes a major factor.

Purposes of Tillage. Major purposes of tillage in the Plains region are: *(a)* to produce a suitable seedbed, (b) to destroy weeds and conserve soil moisture, and *(c)* to maintain soil and surface conditions resistant to erosion. It is possible to obtain effective weed control by repeated cultivation. Unfortunately frequent cultivation of the soil increases the hazard of wind erosion. On the other hand, weeds must be destroyed if moisture is to be conserved. Obviously the soil requires careful treatment under these conditions if erosion is to be avoided, weeds controlled, and moisture conserved. To achieve these objectives proper choice of implement and method and timeliness of operation are imperative. Implements must bury or preserve crop residues on the surface, increase or decrease soil cloddiness, roughen or smooth the surface, if and when required.

Size and Method of Operation of Farms. The size of individual farm units in the Great Plains has increased steadily during the past 25 years. As an example, statistics (11, 12) show that the average size of a wheat farm in Ford and Greeley counties of Kansas in 1925 was 249 acres. The average for 1950 was 372 acres. In addition, the number of farms in the two counties having 1,000 acres or more has increased from 104 in 1925 to 251 in 1950. All this means that 25 years ago many small machines were doing a job now done by a few large machines. The advent of this type of farming has required that machines be so designed and of such size as to permit coverage of large acreages in a manner which gives adequate erosion control under the direction of one man.

Major Factors Controlling Wind Erosion

Many factors influence the amount of erosion in a given agricultural area. Factors over which man has little control are the climatic conditions and the topographic features of the land. Of the group over which he exerts some influence the three most important are the soil cloddiness, surface

Paper presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1955, on a program arranged by the Soil and Water Division. Approved as contribution No. 552 of the department of agronomy, Kansas Agricultural Experiment Station, and the soil and water conservation research branch (ARS), U. S. Department of Agriculture (Cooperative Research in the Mechanics of Wind Erosion).

The authors—N. P. Woodruff and W. S. Chepil—are, respectively, agricultural engineer and soil scientist, Western Section of Soil and Water Management, (ARS), U. S. Department of Agriculture.

Acknowledgment: The authors are grateful to the Caterpillar Tractor Co. for supplying some of the equipment used in obtaining part of the data presented in this paper, and to Kansas Agricultural Experiment Station personnel for assistance in carrying out portions of the work.

*Numbers in parentheses refer to the appended references.

roughness, and crop residues. Studies (7) have shown that as much as 75 percent of the variability in amount of erosion can be attributed to these three factors. Tillage machinery exerts an exceedingly important influence on the state of all these factors. It would therefore seem that the job expected of tillage equipment should be evaluated in terms of these three factors. A prerequisite to this evaluation is an understanding of the nature of the effect of the factors.

Residues. The amount of protection afforded the soil by crop residue is dependent upon type, quantity, evenness of distribution, anchorage, and vertical orientation of residue. A standing crop or crop residue is more effective than a flattened one because it is more capable of reducing the force of the wind on the ground surface.

Soil Cloddiness. Studies (5) have shown that soil erodibility varies inversely with the percentage of clods greater than 0.84 mm in diameter. The proportion of these nonerodible fractions depends on the physical and chemical characteristics of the soil, the factors of weather and climate, and tillage and cropping practices.

Surface Roughness. The rougher the surface, the greater is its tendency to lower the surface velocity of the wind and to reduce the movement of soil. Surface roughness is difficult to measure and divorce from crop residues and cloddiness. Any obstruction, whether it is a ridge, a depression, a large clod, or a piece of residue standing above the soil surface will serve as a roughness element. Since linear measurements of such a group of dissimilar objects would mean very little, it has been necessary to provide an alternate measurement. Zingg (13) has proposed a roughness equivalent which evaluates the roughness in terms of a height-spacing ratio of 1 to 4 of gravel ridges constructed in a wind tunnel. Thus, if a surface has a roughness of 4 in, it will resist the wind to the same degree as gravel ridges 4 in high and 16 in apart when placed at right angles to the wind.

The interrelationship of these three variables has been found to fit the exponential equation (6, 7):

$$E = a\frac{I}{(RK)^b}$$

where E is amount of erosion in tons per acre, I is a dimensionless index based on percentage of clods greater than 0.84 mm in diameter, R is amount of residue in pounds per acre, K is ridge-roughness equivalent in inches, and a and b are constants whose value depends on the condition of the surface crust and the immediate past history of erosion on the field. This equation correlates the results of many different soils and field surfaces tested during the last five years with a wind tunnel.

Functional Requirements of Tillage Equipment

The foregoing portion of this paper indicates in a general way the requirements of tillage tools for wind-erosion control; i.e., they should leave a rough and cloddy surface, a residue-covered surface with residues well anchored and standing if possible. Suffice to say that any one of these conditions considered individually would indicate several different functional requirements for a given implement. From a practical standpoint, the best conditions for wind-erosion control cannot be the only standard by which the requirements of tillage equipment are determined. For example, there is the requirement of a good seedbed; this usually means a smooth, bare, mellow-surface condition.

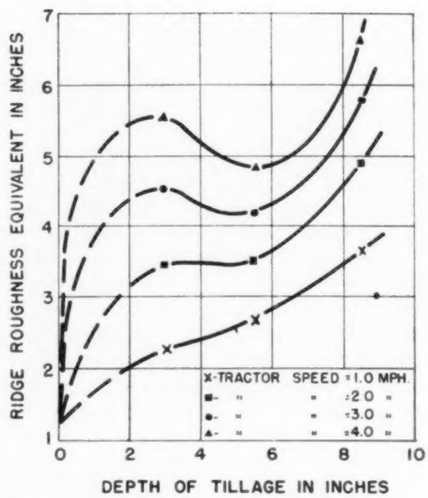


Fig. 1 The effect of depth and speed of tillage on surface roughness. The land, a silty clay loam having 16.3 percent moisture in the tillage layer, was tilled with a chisel of the type commonly used in emergency tillage operations

Since these requirements are opposed to those for wind-erosion control, a compromise must be made between the two. In view of these considerations some of the more important general requirements of tillage equipment are:

1. *A variety of adaptable equipment must be available.* Since no single tillage implement that meets all the requirements for tillage is available at the present time, a selection or "line" of tools must be available. For the initial tillage operation, one-way disks, plows, or sweeps must be capable of cutting through heavy wheat or sorghum residues, leaving them well anchored and standing if possible. At the same time either a minimum pulverization of the soil or a maximum cloddy condition should be created. Rod weeders, disks, spring-tooth harrows, or skew treaders are often needed for the subsequent cultivation and seedbed preparation. These tools should pack the seedbed, kill the weeds, leave the residue on the surface, and not clog or drag the trash. Planters and drills with adequate coulter, knife, or jointer action to cut through residues and to place the seed well into the ground must be available. Often yields are increased when wheat is planted with a deep-furrow drill, not only because the seed is placed in a better moisture environment, but also because the rough surface reduces wind action and traps water. Crops such as sorghum often require planters with wider spacing than those on drills. This type of machine is, therefore, a necessity where such crops are grown. The emergency tillage operation, of course, requires still a different type of implement. Chisels and listers are most commonly used. The chisels do very well on hard lands but on sands listers are almost a necessity.

2. *The tillage implement should provide adequate facilities for adjustment and variation of the depth of tillage.* Depth of tillage is an important factor with reference to roughness and soil cloddiness. It is not so important as far as preservation of residues is concerned. Studies (6) have shown that the stability of clods increases with depth below the surface of the ground. Since stability is a very important secondary factor governing the length of time a cloddy

Fig. 2 An example of the pulverization of the soil surface by the wide tracks of a heavy tractor

surface will stay resistant to wind erosion, it is apparent that adequate depth adjustment is essential to obtain these stable clods.

Adjustment of depth of tillage is important in operations using subsurface tillage sweeps. Studies of stubble-mulch farming practices (9) indicate that better weed control and seedbed conditions can be obtained by deep tillage on the initial cultivation followed by less depth with each successive cultivation.

The effect of depth of tillage on roughness is an important factor in emergency tillage operations (Fig. 1). It is noted that for conditions of this test, depth of tillage had a variable effect on roughness and a greater roughness was created by tillage at a 3.0-in depth than a 5.5-in depth for the faster speeds. This was caused by greater upheaval of clods at the 3.0-in depth than at the 5.5-in depth. At the

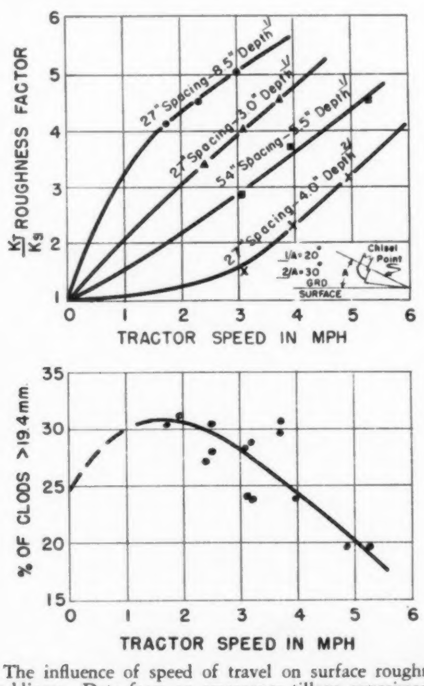


Fig. 3 The influence of speed of travel on surface roughness and soil cloddiness. Data from an emergency tillage experiment where the land was chiseled.

Fig. 4 View of a chiseled plot which meets the requirements for effective emergency wind-erosion control. Surface roughness was 5.4 in; clod structure, 69 percent >0.84 mm; measured erodibility, 0.04 tons per acre. Plot was tilled at 3-in depth at the speed of 3.7 mph

8.5-in depth, however, a "mole effect" was obtained, leaving an undulating surface giving a greater roughness equivalent as measured by the wind tunnel. The surface created by tillage at this depth may not necessarily be the most resistant to wind erosion because of insufficient upheaval to give a uniformly cloddy surface.

3. *Sufficient power, traction, and speed should be available.* Adequate power is important where extensive acreages are farmed with large equipment. It must also be available for such operations as deep plowing, disruption of plow pans, and for tillage of extremely dry, compacted soils.

Traction is extremely important on sandy lands. If adequate wheel traction is not provided, it is nearly impossible to handle this land properly. Traction is also of some importance in its effect on compaction and pulverization of soils. The conflicting requirements of avoiding pulverization but at the same time providing adequate traction often create problems. A prime example of this is shown in Fig.2. Here a track-type tractor has provided ample traction, but the tracks have pulverized the soil to such an extent that these areas are vulnerable to erosion.

Speed of operation of the tillage tool has a very significant effect on how well a given tool meets the requirements for effective wind-erosion control. In the type of agriculture practiced in the Great Plains today, speed is a necessity in many cases in order to cover the land. This is particularly true in the emergency tillage operation. It is, therefore, difficult to prescribe a speed which will permit completion of the operation in the allowed time and still do an adequate job. The speed of travel affects all three of the major variables, *i.e.*, roughness, residues, and cloddiness. Both the degree of burial and anchorage of residues can be regulated by speed of travel. Too much speed tends either to bury most of the residue or to throw it on the surface in an unanchored condition. The effect of speed of travel on cloddiness and surface roughness is indicated in Fig. 3. Roughness is plotted as the ratio of K_t, roughness of tilled surface, to K_s, roughness of untilled surface. Cloddiness is in terms of the largest size clods as measured by a rotary sieve (4). It is noted that excessive speed breaks down clods but increases roughness. Since it is necessary to have a balance of these two variables, a compromise must be made. In this particular set of tests it was found that a speed of approximately

3.7 mph most nearly met the requirements for good tillage (Fig. 4).

4. *The tillage machine should have proper tool head designs for the particular job.* The size, shape, and design of a given tool head, whether it is a plowshare, a disk, or a chisel or cultivation point has considerable influence on the kind of tillage the machine will do. On plows the shape of the moldboard affects the amount of inversion of the soil layer which in turn affects the roughness, the cloddiness, and the burial of residues. On disks the concavity of the disk creates the vertical forces (1) which also affects residues, roughness, and cloddiness. On subsurface tillage tools, sweep blades that are convex upward give more suction and greater pulverization than flat blades (8). High-lift blades give a higher degree of pulverization but tend to furrow and ridge the soil when it is loose (2). On chisels and subsoilers the shape of the points affects both roughness and cloddiness. The effect of a slight change in the shape of a chisel point is shown in Fig. 5.

5. *Tillage equipment should have adequate vertical clearance.* This feature is very important in all initial and cultivation operations on land covered with heavy wheat or weed residues where clogging and dragging become a problem.

6. *All equipment should have sufficient effective coulter, knife, or jointer action ahead of principal tool carrier.* This requirement is important in moldboard plows, subsurface sweeps, and in some types of drills and planters working on land covered with heavy residues.

7. *Disk-type tools should be provided with adequate gang-angle adjustment.* This is an important feature because of the influence on burial of residue, pulverization of the soil, and soil surface roughness.

The foregoing list of seven requirements does not cover all the features needed in tillage implements for farming in the Great Plains. It merely points out those that seem to be of the greatest importance with reference to creating the desired conditions for residues, roughness, and cloddiness for wind erosion control.

Conclusions as to Effectiveness of Equipment

Present-day equipment, if operated properly, seems to meet most requirements for effective wind-erosion control. Studies of methods of controlling wind erosion (3) indicate that certain tools more nearly meet specific wind-erosion control requirements than others. Residues, for example, are usually best handled with the sweep-type implement because it cuts under the material leaving it in an erect position most effective against wind. The next best implement would be a properly angled one-way disk which leaves the material in a partial standing position. The moldboard plow does not meet the requirements for preserving residues on the surface. However, if residues are meager or absent, the plow under some soil moisture conditions is a good implement for creating a rough, cloddy surface resistant to wind erosion. Disk-type tools, such as the vertical disk or one-way, are usually not satisfactory for creating cloddiness Subsurface sweeps are even poorer for this purpose. The greatest surface roughness can be created by a lister; hence it is particularly useful where residue covers are poor. Deep-furrow drills for wheat planting and furrow-opener-type planters commonly used in sorghum planting are very good for creating a rough surface and for placement of seeds where they germinate readily.

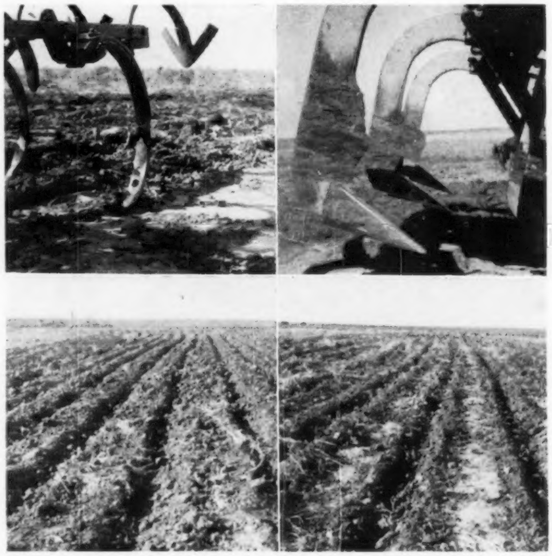


Fig. 5 An example of the difference in tillage caused by changing tool head designs. Two different chisel points (Upper views) and the type of tillage accomplished by each (Lower views). Both tools were operated at same speed and depth

While present-day equipment can do a reasonably good job of wind erosion control, it needs to be improved. Better methods of operating the available equipment are needed also. More information is required on the effect of speed on all phases of tillage to establish criteria for improved operation. The problem of "plow pans" believed to be associated with certain methods of tillage needs to be alleviated. Weed problems, such as control of "cheat" in wheat in some areas of Oklahoma, sometimes are associated with methods of tillage. Such problems may be solved by improved tillage techniques.

Probably one of the greatest needs for wind-erosion control is an implement that will do a better job of creating a cloddy soil surface and at the same time avoid burying the crop residue. Transport and traction of tillage machinery could be improved, particularly for tillage in sands and other soils that pulverize easily. Equipment used in secondary cultivation operation could be improved to do a better job of killing weeds without dragging or being clogged by the residues.

Finally, there is a need for a versatile tool that can accomplish more jobs. This would reduce the need for a "line" of equipment and would be desirable from the farmer's standpoint insofar as his investment in machinery is concerned.

References

1 Bainer, Roy; Kepner, R. A., and Barger, E. L. Engineering elements of farm machinery. Lithoprinted Edwards Brothers, Inc., Ann Arbor, Mich., second printing, 1954, p. 8.2.

2 Chase, L. W. A study of subsurface tiller blades. AGRICULTURAL ENGINEERING, 23:43-45, 50, February, 1942.

3 Chepil, W. S. and Woodruff, N. P. How to reduce dust storms. Kansas Agricultural Experiment Station Circular 318, March, 1955.

4 Chepil, W. S. Improved rotary sieve for measuring state and stability of dry soil structure. Soil Sci. Soc. Amer. Proc., 1951. 16:113-117, April 1952.

(Continued on page 758)

Mobile Celery Harvesting-Packing Combine

Saves Labor; Speeds Operation

John W. Randolph
Member ASAE

A notable example of mechanization applied to the harvesting and preparation for market of an important food crop, especially with respect to some of the factors influencing the utilization of labor, is presented in this article

HIGHLY competitive factors have resulted in reducing the number of celery growers in Florida to only a few, who annually produce, in large specialized operations, on a total area of approximately 10,000 acres. A new mobile unit has been developed which permits combining the operations of field harvesting and packing of celery, thereby eliminating the need for a central packing house and reducing the time period between harvesting and precooling the commercial package. This is highly important to the preservation of quality of a fresh, leafy product. A study made to obtain information on certain factors influencing the efficiency of labor utilization with this new system, is reported in this paper.

The packing of uniform high-quality celery is dependent upon critical inspection and careful handling of each individual stalk. Celery is a brittle crop that requires careful handling, because slight injuries may develop into significant losses during the period associated with transportation, marketing and home storage. The actual selection or rejection of a single stalk is often dependent on the eye for detecting the slightest evidence of certain biological factors that under given conditions could cause major loss.

Certain techniques and quick decisions are required in celery harvesting and packing especially in trimming the plant to its optimum commercial size and in working out an attractive commercial package. Until suitable labor-saving machinery has been devised that will equal the work of the human hand, the efficiency and costs of celery harvesting and packing will in large part depend upon *(a)* training labor and closely supervising it by methods that promote work incentive and *(b)* eliminating all physical effort that does not contribute directly to consumer acceptance.

Therefore, the primary problems in celery harvesting and packing under the new system of using a packing combine are as follows:

- Hand cutting of the celery plant and trimming or stripping of the stalk to an attractive shape and to a size so it fits firmly into a packing crate. The sizing process includes the discarding of all stalks or plant parts that have inherent factors which will reduce quality and keeping qualities of the product.
- Topping the stalks to a uniform height. (The stalks are aligned by hand before they are topped with a circular saw during travel on a conveyor belt.)
- Mechanical washing with spray and recirculating water.
- Hand selecting and assembling of celery stalks of like size.
- Packing a definite number of stalks into a crate by hand in a pattern to give a firm pack without mechanical injuries.
- Closing, labeling, and transporting the commercial package to the precooler.

Paper presented at the annual meeting of the American Society of Agricultural Engineers at Urbana, Ill., June, 1955, on a program arranged by the Committee on Farm Work Efficiency.

The author—JOHN W. RANDOLPH—is an agricultural engineer, Everglades Experiment Station, University of Florida.

Acknowledgment: The author expresses his appreciation to Sam Knight, manager of the Belle Glade farm of A. Duda and Sons, for making available the daily field records used in this report, and to Warren Battle, bookkeeper, for his assistance in assembly of the original data. Helpful information and insight into labor-management problems were provided by key men of the Duda organization and by managers of other farm organizations which use the mobile system of celery packing. The assistance of Mrs. Lillian S. Kemper has been of great help in handling the card system used in the correlation study. The field photograph of the harvester was made by W. T. Forsee.

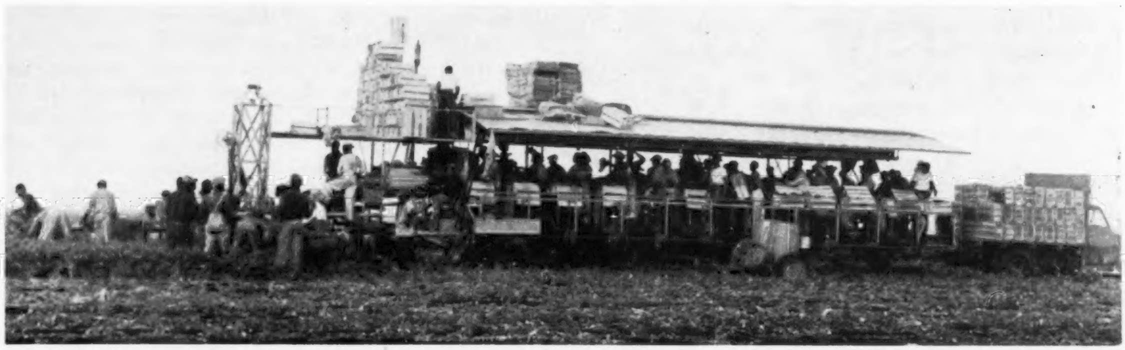
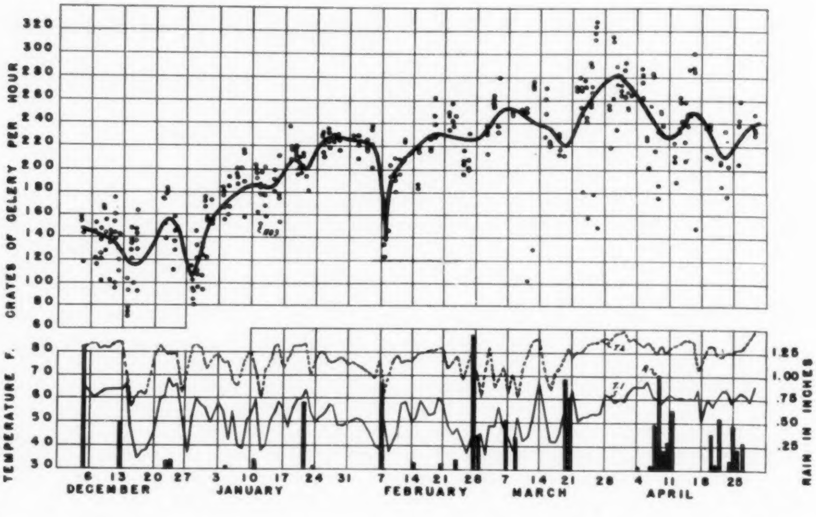


Fig. 1 A general view of the mobile celery harvesting-packing combine developed by John Duda, of A. Duda and Sons, Belle Glade, Fla. The men shown in the foreground cut the celery plants, strip away leaves to size, and place stalks on a T conveyor. A washing unit is located under the empty crates. Packing operations are on the rear of truck. A highway truck is shown being loaded in rear of the unit

Fig. 2 *(Right)* Crates of celery packed per machine-crew hour by dates for the 1953-54 season on the Belle Glade, Fla., farm of A. Duda and Sons



Crew balance, opportunity to apply work-incentive wages under a system of quality control, and a rapid movement of the celery crop from the field to the precooler are the results of the development and use of the novel equipment described in this paper. Credit for this development belongs to John Duda, A. Duda and Sons, Oviedo, Fla., who has been issued a patent on the equipment by the U.S. Patent Office. This patent, like many others which cover a translocation and some modification of currently accepted work practices, cannot give complete credit due to many individuals who may have made contributions to this idea which has now become a workable system.

Fig. 1 is a general view of the Duda celery harvester-packer combine. The basic element of the over-all design is a T-shaped layout of conveyors which permit a continuous flow of the harvested crop through the final processing and packing operations. The major element of the combine is an oversize truck which has many wheels equipped with airplane tires to provide support on the muck soil on which the combine is used.

Fig. 1 shows many men working both on the ground and over 22 rows along the forward cross conveyors. These men, called strippers, cut the plants free from their roots, strip the stalks to grade sizes and deposit them in like pattern on the side conveyors. The celery stalks as they move on the feed conveyors are mechanically topped. The initial stripping and topping of the celery stalk gives a fair distribution of waste products over the field.

A central conveyor extending the length of the mobile unit moves the harvested celery through a washer and then past grading stations where laborers select, grade and pack like sizes of stalks into a commercial shipping crate. Crates are assembled on the roof of the vehicle and by an arrangement of slides, conveyors and hand operations are packed and moved to a truck towed by the combine.

Labor organization and responsibility in connection with this equipment involved 384 actual daily farm records for individual machine crews during the 1953-54 season at the Belle Glade farm of A. Duda and Sons. These records at times represent side-by-side operation of six machines with the majority of the daily reports covering the use of four units. The average crew organization was as follows:

1 machine foreman
1 machine driver
2 crate makers
1 stripper-crew foreman
16 strippers or harvesters
2 cut-off men
1 packing crew subforeman
20 graders and packers
7 take-off men
2 crate closers
1 stacker
1 labeler
3 truck drivers

The above gives an average total machine crew of 58, which does not include the services of men employed in the maintenance of the equipment.

The mobile system of harvesting and packing celery has simplified part quality control measures and labor-supervision problems. Formerly independent work operations were divided into eighteen or more job classifications located in the field and at the central packing house. The old program frequently contained long periods in which the celery was subject to wilting by the sun and wind. Celery in a wilted condition can be handled by relatively rough methods.

The recent market demand for the Pascal variety of celery has caused a reduction in the acreage planted to the Golden variety of celery which on an average basis takes more stalks to fill a commercial crate. The shift to the Pascal variety, that considered in this report, has been more or less concurrent with the introduction of mobile systems of packing. The two changes have produced in part an erroneous conclusion that the machine has caused a major reduction in labor requirements. A preliminary comparison of two sources of data shows that both the old and the new system requires approximately 70 man-hours to harvest and pack 10,000 stalks of celery. The significance of this common value must be weighed by other resulting values.

Crates of celery are the customary unit of measure because market values do not consistently reflect the actual grade sizes. The commercial market recognizes nine size groups making up packages that vary from 1½ to 12 dozen stalks per crate. The original data in Fig. 2, expressed as number of stalks harvested per hour, tends to level out seasonal differences in crop production, variation between varieties and special market qualifications.

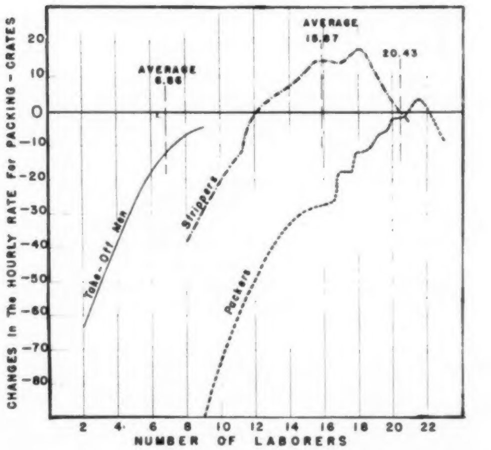


Fig. 3 Average rate of celery packing per machine-crew hour as influenced by the number of laborers used as take-off men, strippers (or cutters), and packers

The daily output of each machine crew, shown as circled points in Fig. 2, varies from 70 to 329 crates packed per hour. Fig. 2 also shows the maximum and minimum temperature and the inches or rainfall by dates. The scattered array of points permit the general assumption that there are many factors which have modified crew output. Without going into preliminary details an actual celery harvesting-packing crew might be compared to a boy's sandlot ball team that is subject to frequent reorganization and substitution of players. The relative output from the six celery harvesting crews have had frequent extreme variations from day to day. The shaded circles in Fig. 2 show the lack of uniformity of output from machine number 3. This holds for other crews also.

Graphic multiple-correlation studies were used to make determinations of the reactions of known factors from the mean output curve in Fig. 2. Fig. 3 shows a definite reaction to be associated with the number of laborers assigned as strippers, packers and take-off men. There is evidence that 12 good strippers can give an average capacity operation, but with continuous operation the records prove that more men are needed. The relatively small increase in output associated with an added number of strippers over 12 might not be justified in an economic analysis. However, in practice in the Glades it is necessary to overman an operation at times as a means of offsetting absenteeism of some laborers who will only work two or three days per week.

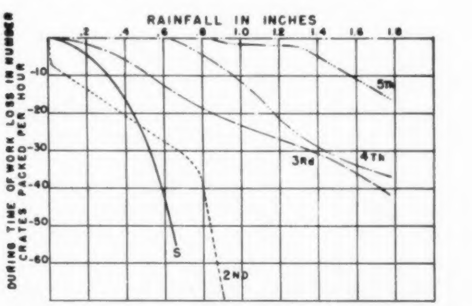


Fig. 5 Variations in crates packed per machine-crew hour creditable to rainfall during the work day and on previous days

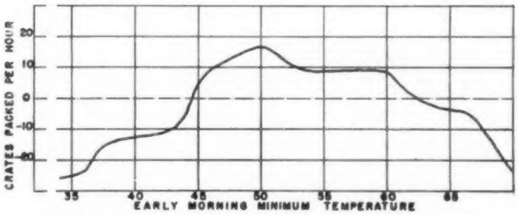


Fig. 4 The influence of the minimum temperature on the average rate of celery packing per machine-crew hour

The packer-job assignment curve in Fig. 3 is of special interest because it reflects minor, within the day, changes in the number of laborers used. This and the "strippers" curve show that it is possible to overcrowd and thereby disrupt the most effective working relationship. The Duda celery combine has 20 packing tables or free working space for 20 workers. The effective distribution of grade-size packing assignments to laborers represents many problems with so many details in work organization that this phase of the subject will not be covered in this report.

The take-off man is a handy man who helps the packers at times, removes the filled crates, and makes ready an empty crate. The curve showing the effect of number of take-off men on output in Fig. 3 gives a positive increase with the number of men up to eight. The drop shown for the ninth man may be attributed to crowded working conditions.

Studies of wind velocity, wind direction and maximum temperature variations produced no correlation to number of crates of celery packed per hour. Such results might be expected because a harvester-packer unit has a roof and drop curtains to protect the majority of the laborers. Minimum temperature influenced the start of a day's work and thereby modified a crew's average output rate as shown in Fig. 4. It is evident that work is slowed down in cold weather when laborers handle wet celery with their bare hands.

The celery harvesting crew's mental reaction to work differed according to the day of the week. The Friday record is of special interest because it is the last day of the pay period. It is evident that laborers make a last-day effort to build up cash credits under a system of output incentive payments.

DAILY VARIATIONS IN CRATES OF CELERY PACKED PER HOUR PER MACHINE

Day of Week	Variation in number of crates from the mean Plus	Minus
Monday	———	9.89
Tuesday	2.92	———
Wednesday	———	3.99
Thursday	.62	———
Friday	12.63	———
Saturday	———	34.26

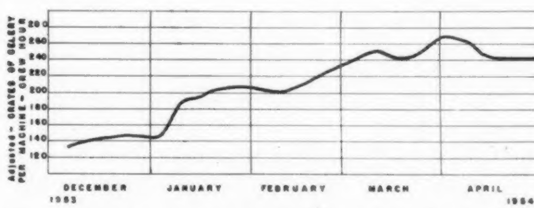


Fig. 6 Adjusted curve for crates of celery packed per machine-crew hour

Variations in output creditable to rainfall are given in Fig. 5. This analysis does not consider zero conditions of output when laborers were not called to work or were released after a rain. From the five curves and the uanvoidable no-work periods it is evident that rainfall has a major influence on output.

The frequent shifting of foremen and subforemen between machines permitted a study that credited each man with definite influences on the output. Such a study is of greatest interest to management because it reflects the supervisory qualifications of specific individuals. The available data on the variations of methods used by several foremen are too limited for a summary discussion in this report.

The modernization of celery harvesting and packing operations into a centralized mobile combined field system has permitted delivery of the freshly packed product to the precooler in a very short time interval after harvesting. The Pascal variety has been packed by a well-trained crew in balanced work assignments into a large number of crates per hour. Reduction from the high rates of packing have in part been explained by certain factors in this report.

Implements For Wind Erosion Control

(Continued from page 754)

5 Chepil, W. S. Factors that influence clod structure and erodibility of soil by wind: I. Soil texture. *Soil Sci.* 75:473-483, 1953.

6 Chepil, W. S.; Woodruff, N. P. and Zingg, A. W. Field study of wind erosion in western Texas. U.S. Soil Conservation Service TP-125.

7 Chepil, W. S. and Woodruff, N. P. Estimation of wind erodibility of field surfaces. *Jour. of Soil and Water Conserv.* 9:257-265, 285, November, 1954.

8 Duley, F. L. and Russel, J. C. Stubble-mulch farming to hold soil and water. USDA Farmers Bulletin 1997, 1948.

9 Johnson, Wendell C. Stubble-mulch farming on wheat lands of the Southern High Plains. USDA Circular No. 860, August, 1950, p. 16.

10 Lyon, T. L. and Buckner, H. O. The nature and properties of soils. MacMillan Co., New York, fourth edition, 1948, p. 283.

11 United States Census of Agriculture. Part I, The Northern States, 1925, p. 1260.

12 United States Census of Agriculture, vol. I, Counties and State Economic Areas. Part 13, Kansas, p. 95, 1950.

13 Zingg, A. W. and Woodruff, N. P. Calibration of a portable wind tunnel for the simple determination of roughness and drag on field surfaces. Agron. Jour. 43:191-193, April, 1951.

Management Engineering in Agriculture

(Continued from page 750)

The field baler is not, in and of itself, related very well to field loading, or to conveyance into or out of storage, and still less to self feeding of the products. Is not the field baler essentially an adaptation of earlier stationary machines, whose chief function was to compress and bind hay into large, substantial shipping units for the commercial hay trade? There is still too much hand labor ordinarily required to integrate the baler into a total system of harvest, conveyance, storage, and feeding. Are we, perhaps, bending ourselves around a machine which was designed basically for a form of product destined for distant markets rather than for home farm use? The bales are such elemental and sturdy building blocks, capable of being stacked in an infinite variety of combinations to fit presently available space, that we are apt to overlook the fact that immense tonnages are being handled manually with no aid except a bale hook.

This article will not discuss all other forage harvesting equipment, but the question can be asked whether all has been done that may be done with field-chopped hay. True, it is loaded by power in the field in direct association with the chopper, but what happens from then on? Do unloading devices at the barn take full advantage of the form the hay is in, i.e., a mass of relatively fine particles, roughly alike throughout the load and from load to load, and confined in a specific rectangular wagon or truck body which could easily and simply be positioned every time in precise relationship to a power-driven unloader? The dimensions of an unloader and its range of action could be related exactly to the dimensions of the hauling vehicle, and its rate of feed coordinated moment-by-moment with the instantaneous capacity of the conveyor or blower.

After the chopped hay is in storage, what happens? There is where, for the most part, muscle power still prevails. Too frequently, the hand fork is the farmstead complement to the 40-hp field machine. We need new concepts on the handling and storage of chopped hay. We should be impelled, by consideration of the fact that hay blown into a space has to be moved out again and conveyed to feeding bunks, to seek improved means of handling which would reduce both damage to the hay and the labor of handling it.

Similar analyses could be applied to the same forage preserved as silage rather than as hay. Development of integrated systems in the harvesting, storage, and handling of silage seems to be more advanced than for hay—fortunately so, because of the greater weight involved for a given amount of feed. But here, too, much remains to be done.

My purpose has not been to indicate, or infer, superiority as between baling, field chopping of dry hay, or grass silage. Perhaps all three forms — indeed, probably all three — have advantages sufficient for their retention.

The purpose of this discussion of forage, and of this entire article, is to suggest that one of the big and continuing jobs for agricultural engineers is to follow through on the full implications of any form of product being handled on farms. I think it is fair to say that we have tended to work too much in compartments—labeled farm machinery, farm structures, rural electrification, and so on—and that, in consequence, there has been too little effort at integration of processes, machines, structures, and forms of product into systems rationalized and integrated around a farmer's total operations. One major reason for this compartmentation is, no doubt, the usual separation in time and space between field operations and related farmstead operations which may occur months later. The farmer, however, encompasses them all in his yearly cycle of operations, and his overall efficiency is significantly limited by the weakest element in his system. Every farmer has a "system"—some good, most of them ill-balanced. In fact, most farms have more than one system and several subsystems. As the engineers of agriculture, let us therefore, as management engineers for agriculture, turn our attention more consciously to research and development aimed at better balanced, more efficient farm systems.

TECHNICAL PAPER ABSTRACTS

Following are brief reviews of papers presented at ASAE meetings. Information concerning complete copies of these papers may be obtained by writing to the American Society of Agricultural Engineers, St. Joseph, Mich.

Basic Egg Cooling and Moisture Loss Studies, by S. M. Henderson, professor of agricultural engineering, University of California, Davis. Presented at the annual meeting of ASAE in Roanoke, Va., June, 1956, on a program arranged by the Rural Electric Division. Paper No. **56-31.**

The increasing use of cold storage rooms for eggs to minimize grade and value decline between the time eggs are laid and delivered to market, is the basis for this article. A study of basic egg cooling and moisture loss procedures was made to provide design data for the cooling and holding system so that maximum egg quality could be assured with a minimum initial and operating expense for refrigeration.

The cooling and moisture loss indices of single eggs were determined. Cooling and moisture loss rates of quantities of eggs in wire baskets, fillers and flats, filler-flats, and various cases were observed. These data permitted precooling and holding design recommendations (temperature, relative humidity, air rate, cooling time) that will permit a minimum of quality reduction while the eggs are retained on the farm.

The author reports that performance will be generally acceptable if the room temperature is below 60 F, the gathered eggs are cooled within 4 or 5 hours after being laid, and humidities are maintained at a practical high level. A chart was developed for predicting grade reduction due to moisture loss when stored at a specific temperature and relative humidity for a specific time.

•

Estimating Irrigation Requirements, by Robert S. Palmer, chairman of agricultural engineering, University of New Hampshire, Durham. Paper presented at the North Atlantic Section of the American Society of Agricultural Engineers in Ithaca, N. Y., August, 1956. Paper No. **56-33.**

This paper introduces a technique for presenting data which may be effective in estimating irrigation water requirements based on a study of rainfall records and the estimation of soil moisture deficiencies. A comparison of the results using a balance system which assumes field capacity at the beginning of the growing season and one which considers winter precipitation shows the value of the latter procedure. Using three Blaney-Criddle crop coefficients to estimate consumptive use, a study of soils assumed to have an available moisture holding capacity of zero to 12 in of moisture in the root zone depth shows that in Durham, N. H. (and the inference is that it probably holds true for most locations) during a crop's growing season additional water artificially applied will benefit the plant. Comparisons of water deficiencies for soils with a range of moisture capacity of from 1 to 5 in of available moisture, and for maintaining soil moisture above zero deplete and 40 percent deplete, are also made.

Introductory Speech, Special Soil and Water Program for Public Lands and Public Works by Capt. J. A. Stelger, assistant chief, Bureau of Yards and Docks Planning and Design, U.S. Navy Department. Presented at the annual meeting of ASAE in Roanoke, Va., June, 1956, on a program arranged by the Soil and Water Division. Paper No. **56-35.**

Land problems faced by the federal agencies who construct and maintain public works and maintain public lands are reviewed in this paper. These agencies share a common difficulty in their soil conservation and erosion control problems, in that they must do the job with appropriated funds. The lands connected with these projects are each an integral part of a watershed at some community, and because of the interdependance of all lands on a watershed, each of these agencies carries a responsibility to cooperate in many of the over-all plans for community developments.

The problems encountered are broad, and the technical subject matter required is contained in many professional fields such as hydrology and hydraulics, soils and geology, climatology, biology, agronomy, botany and forestry, and civil engineering. In each of these there are usually important modifications to be made for best results in local application.

Obviously, it is not practical for the U. S. Navy to employ technically trained specialists in all these subjects, in each community where it has public lands and public works. But it does get these services from professional people regularly employed in, and therefore familiar with the area in which projects are located. These services are obtained on a reimbursable basis from agencies such as the Soil Conservation Service of the U.S. Department of Agriculture, and from local soil conservation districts.

To reduce the land maintenance job, agricultural and grazing leases are made for security strips and lands for which construction projects are pending.

Major land problems are relatively new to the Navy, but these problems are being solved through cooperative work with agricultural agencies and guidance by a comprehensive Navy policy of conservation.

•

Outleasing Navy Lands, by Lawrence B. Bassett, Ninth Naval District, Great Lakes, Ill. Presented at the annual meeting of ASAE in Roanoke, Va., June, 1956, on a program arranged by the Soil and Water Division. Paper No. **56-37.**

This paper illustrates the main points for consideration in the outleasing of Navy lands. It is the policy of the U. S. Navy to develop soil conservation plans for the land it must hold for defense purposes. The soil conservation plans are developed and selected by preparing a soil map, a capability map and listing alternative land uses and supporting practices. The agricultural outlease is drawn around the soil conservation plan, thus offering protection for the land inventory. Certain items of maintenance are included in the lease as a means of accomplishment and reduction in direct cost to Navy funds.

Local agricultural leaders are consulted regarding the proposed lease thus acquiring local opinion and understanding. This leads to better bids and acceptance of Navy activity in agricultural communities. Navy leases are limited by law to a 5-year period unless an exception is made by the Secretary of the Navy. This uniform lease period makes planning and application of erosion control more difficult as the land and its needs are quite variable. They afford a means of local income from land used for defense purposes.

Points to be considered in outleasing Navy lands are: *(a)* Agricultural outleases are based on conservation plans which match land use with capability, consistent with local practice and needs, *(b)* The lease must include sound erosion control and good farm management practices, *(c)* The terms of the proposed lease should be discussed with local farm leaders, *(d)* A good agricultural outlease provides for the protection of land resources at minimum cost to the Navy, and *(e)* The agricultural outlease affords the community a source of income from these lands.

•

Survey of Machinery Requirements for Soil and Water Conservation, by T. W. Edminister, agricultural engineer, Soil and Water Conservation Research Branch, ARS, USDA, Beltsville, Md. Presented at the annual meeting of ASAE in Roanoke, Va., June, 1956, on a program arranged by the Power and Machinery Division. Paper No. **56-38.**

This paper reports on progress that is being made in a "teamwork" approach to fitting farm machinery to perform satisfactorily with conservation practices and in modifying and designing new and improved conservation practices that facilitate the change to full mechanization.

The recent trends in minimum tillage for seedbed preparation as exemplified by the New York plow-plant and the Ohio tractor-track planting, combine to reduce labor and machine costs while providing a seedbed having a high infiltration capacity that helps to reduce runoff and erosion. Improvement in crop residue management equipment such as choppers and shredders and in mulch tillage and planting equipment, is making it possible to utilize crop residue with full effectiveness for soil and water conservation protection of cultivated land surfaces.

Integrated conservation practices that include land forming, smoothing, mulch tillage, rotations, etc. are making possible the use of parallel terrace systems and improved strip-crop layouts that are compatible with modern mechanization. Detailed soils studies are aiding in delineating the soil conditions and areas where deep tillage, chiseling or subsoiling will give positive benefits in terms of improved root and moisture penetration.

Many problems remain to be solved, for example, changes in design to reduce power loss and dangerous operating conditions caused by nonsymetrical loading in offset combines, forage harvesters and other equipment, development of mulch tillage equipment to better handle the extremely heavy residues of the Pacific Northwest, the development of low cost equipment for construction and maintenance of drainage systems and for the application of irrigation water. These, and many more problems, are now being looked at on a teamwork basis to fit the conservation practice to the machine and the machine to the conservation practice. The objective? To provide a sound mechanized agricultural conservation program.

1956 WINTER MEETING

Edgewater Beach Hotel, Chicago, Illinois • December 9-12, 1956

REGISTRATION
Sunday, December 9, 2:00 p.m.

Advance registration cards, and hotel reservation forms may be obtained by writing to ASAE Headquarters, 420 Main Street, St. Joseph, Mich.

Monday Morning December 10

Four Concurrent Programs

(1) Power and Machinery Program

Presiding: *L. G. Kopp,* chairman, Power and Machinery Division

9:30 Features and Applications of Ball Screws—*C. W. Lincoln,* Saginaw Steering Division, General Motors Corp.

10:00 Lower Part Cost by Projection Welding (Abstracted for presentation)—*C. H. Burgston,* Deere and Co.

10:40 Development of Flail-Type Harvesters—*Andrew M. Cowan, Jr.,* and *Dale O. Hull,* Iowa State College.

(2) Soil and Water Program

Presiding: *Louis M. Glymph, Jr.,* chairman, Hydrology Group

9:00 Application of Statistical Methods to Small Watershed Hydrology—*Ven Te Chow,* University of Illinois.

9:40 Soil Conservation Service and Corps of Engineers Coordinated Watershed Plan for Chambers Creek, Texas—*E. C. Buie,* SCS, USDA, Spartansburg, S. C.

10:30 U. S. Weather Bureau Program of Reporting Crop Moisture Deficits—*L. T. Pierce,* U. S. Weather Bureau, Columbus, Ohio.

11:05 Effect of Slope and Microtopography on Surface Detention and Depression Storage—*W. N. Stammers,* Ontario Agricultural College.

(3) Farm Structures Program

Presiding: *Price Hobgood,* vice-chairman, Farm Structures Division

9:30 Tilt-Up Concrete Construction — *Maurice Brandt* and *Irving Pflug,* Michigan State University.

9:55 Anchoring of Framed Structures to Concrete Foundations with Fluted Nails — *E. George Stern,* Virginia Polytechnic Institute.

10:20 Cage Housing for the Northern States—*Leonard Z. Eggleton,* Iowa State College.

11:10 New Management Considerations in Swine Housing — *Damon Catron,* Iowa State College.

(4) Rural Electric Program

Presiding: *Ross R. Mauney,* chairman, Rural Electric Division

9:40 Metering Devices for Bulk Milk Handling—*S. A. Witzel,* University of Wisconsin.

10:10 Load Characteristics of Highly Electrified Farms—*L. B. Altman, Jr.,* Iowa State College.

10:40 Hot Water Requirements for Pipeline Milkers—*L. A. Brooks,* University of Wisconsin.

11:20 Developments, Characteristics and Performance of Submersible Pumps—Domestic and Farm Use—*G. A. Patterson,* Perfection Mfg. Co.

12:15 p.m. Noon Luncheon
Atomic Energy and Its Application to Modern Agriculture—*Dr. H. B. Tukey,* Michigan State University.

Rural Electric Division Noon Luncheon

12:15 p.m. Monday, Dec. 10

Dr. H. B. Tukey, head, horiculture department, Michigan State University, will speak on the subject "Atomic Energy and Its Application to Modern Agriculture."

Monday Afternoon December 10

Four Concurrent Programs

(1) Rural Electric Program

Presiding: *Dean L. Searls,* Adams Electric Co-op, Camp Point, Ill.

2:00 Cooling Poultry Houses — *Liston Drury,* University of Georgia.

2:30 Discussion — *Hajime Ota,* (AERB, ARS), USDA, Beltsville, Md.

2:45 Automatic Feed Processing on the Farm—*Ralph P. Prince,* Pennsylvania State University.

3:30 Effects of Atomic Explosion and Radiation on Electric Equipment and Installation—Movie.

(2) Power and Machinery Program

Presiding: *C. S. Morrison,* vice-chairman Power and Machinery Division

2:00 A New Principle in Tractor Hitch Design—*E. W. Tanquary* and *A. W. Clyde,* International Harvester Co.

2:30 Pelletizing Farm Feeds — *H. D. Bruhn,* University of Wisconsin.

(3) Soil and Water Program

Drainage Session

Presiding: *Keith H. Beauchamp,* chairman, Drainage Group

1.30 How Permeability Tests as Measured by Hydrostatic Pressures Up to 100 Pounds May Be a Good Indicator of High Quality Concrete Tile—*Philip W. Manson,* University of Minnesota.

2:00 Drainage Structures — *Melvin M. Culp,* SCS, USDA, Washington, D.C.

2:30 New Device For Measuring Tile Effluent—*Curtis L. Larson* and *Lee F. Hermsmeier,* University of Minnesota.

3:15 New Techniques of Drainage Investigation for Irrigated Lands—*Norman A. Evans,* Colorado A & M College.

3:45 Drain-Yield Estimation for Interceptor Type Drains in Irrigated Areas of Colorado—*W. J. Frederick,* SCS, USDA, Pueblo, Colo.

Farm Structures Division "Milker"

4:00 p.m. Monday, Dec. 10

A Milker will be held by members of the Farm Structures Division to provide opportunity to become better acquainted. Refreshments and entertainment will be arranged.

(4) Farm Structures Program

Presiding: *Frank J. Reynolds,* chairman, Farm Structures Division

2:00 Farm Production Buildings — *E. H. Baade,* Butler Mfg. Co.

2:30 Farm Buildings Designed to Double Volume — Triple Profit — *Cameron Hervey,* Hervey Research and Development Corp.

3:00 Farm Building Loans—*Eli Ferguson,* Equitable Life Assurance Society.

3:30 Financing of Farm Buildings—*Jack Parsons,* LPG Credit Corp.

4:00 Structures Division Milker

Tuesday Morning December 11

Five Concurrent Programs

(1) Joint Farm Structures and Rural Electric Program

(Arranged and sponsored by the ASAE Committee on Agricultural Processing)

Presiding: *Leo E. Holman,* vice-chairman, ASAE Committee on Agricultural Processing

THEME: Evaluation and Control of Quality of Agricultural Products

9:00 An Instrument for Measuring the Rheological Properties of Agricultural Products — *Robert Decker,* USDA, Washington, D. C.

9:30 Heat Transfer in Cooling Fruits and Vegetables — *Rene Guillou,* University of California.

10:00 New Developments in Packaging Agricultural Products — *Donald T. Stokes,* USDA, Washington, D.C.

10:45 Seed Cleaning and Handling on the Farm—*Jesse E. Harmond,* (AERB, ARS), USDA, Oregon State College.

11:30 Engineering Problems in Quality Control During Processing Operations—

(2) Power and Machinery Program

Presiding: *Byron T. Virtue,* junior past-chairman, Power and Machinery Division

9:00 Improvements in Agricultural Implement V-Belt Applications — *James Adams, Jr.,* Raybestos-Manhattan, Inc.

9:30 Progress Report of Committee on Soil Compaction—*T. W. Edminster,* ARS, USDA, Beltsville, Md.

10:00 Observations on Soil Compaction Tests—*A. W. Cooper* and *M. L. Nichols* (AERB, ARS), USDA, Auburn, Ala.

(3) Soil and Water Program

Drainage Group

Presiding: *J. W. Borden,* vice-chairman, Drainage Group

9:00 Drainage Group Business Meeting and Progress Report of Committees.

9:45 SYMPOSIUM: Measurement of Hydraulic Conductivity for Drainage Investigations.

Moderator: *Glenn O. Schwab,* Ohio State University

Field Determination of Hydraulic Conductivity Above a Water Table —*Ray J. Winger, Jr.,* USDI, Bureau of Reclamation, Denver, Colo.

Measurement of Air and Water Permeability of Soil in the Labora-

tory—*Royal H. Brooks*, and *Ronald C. Reeve*, USDA, Riverside, Cal.

Theoretical and Practical Difficulties Found in Some Field Methods of Measuring Hydraulic Conductivity —*R. William Nelson*, ARS, USDA, Fort Collins, Colo.

PANEL DISCUSSION: Field Experiences in Measuring Hydraulic Conductivity, panel leader—*W. W. Donnan*, ARS, USDA, Riverside, Calif. Panel members are: *Phelps Walker*, ARS, USDA, Blacksburg, Va.; *Ben Grover*, Iowa State College; *R. W. Nelson*, ARS, USDA, Boise, Idaho; *John R. Davis*, Purdue University; *F. R. Hore*, Ontario Agricultural College; and *Ray J. Winger, Jr.*, USDI, Denver, Colo.

(4) Soil and Water Program Erosion Control Group

Presiding. *J. J. Coyle*, SCS, USDA, Washington, D. C.

9:00 PANEL DISCUSSION: Problems in Erosion Control Practices Related to Terraces.

Panel members are: A. J. Wojta, University of Wisconsin; C. A. Van Doren, University of Illinois; B. A. Jones, University of Illinois; D. D. Smith, SWC, ARS, Beltsville, Md.; W. E. Larson, ARS, USDA, Iowa State College; and Paul Jacobson, SCS, USDA, Des Moines, Iowa. (Topics of speakers may be found in programs available at registration desk.)

Symposium on Mulch Tillage: Leader—*John A. Allis*, chairman, ASAE Committee on Mulch Tillage.

Panel members are: R. R. Robinson, ARS-SWC, Beltsville, Md., and J. R. Davis, et al, Purdue University.

Report of Committee on Mulch Tillage—*John A. Allis.*

(5) Soil and Water Program Hydrology Group

Presiding: *Howard Matson*, past-chairman, Hydrology Group, and *E. C. Buie*, vice-chairman, Hydrology Group

9:00 Progress Report, Committee on Water Storage and Use — *D. D. Smith*, chairman.

9:15 Progress Report, Committee on Runoff—*W. O. Ree*, chairman.

9:30 Current Program of Research in Evapo-Transpiration—*John R. Davis.*

10:00 Symposium on Evapo-Transpiration —*John R. Davis*, moderator.

Panel members are: *Gilbert Levine*, Cornell University; *John R. Mather*, Laboratory of Climatology, Elmer, N. J.; *C. H. M. van Bavel*, ARS, USDA, Raleigh, N.C.; *L. L. Harrold*, ARS, USDA, Coshocton, Ohio; and *W. A. Raney*, ARS, USDA, Beltsville, Md.

Tuesday Afternoon December 11

General Program

(Arranged and sponsored by the Education and Research Division)

Presiding: *C. G. E. Downing*, chairman, Education and Research Division.

1:30 Engineering for the Creative Age—*Dr. J. R. Ryder*, dean, College of Engineering, Michigan State University.

2:15 Research—Keynote for Industry and Business—*P. V. Moulder*, president, International Harvester Co.

3:15 Research Methods in a New Era—*Dr. Sterling Hendricks*, ARS, USDA, Beltsville, Md.

Soil and Water Program Irrigation Group

Presiding: *C. H. Pair*, ARS, USDA, Boise, Ida.

1:30 Symposium on Irrigation Water Requirements—*J. F. Thornton* (SWC, ARS), USDA, Athens, Ga.; *Roy Garrett*, Texas A & M College; *E. G. Hanson*, New Mexico A & M College; and *C. H. Milligan*, Utah State Agricultural College.

Reports of Committees on: Intake Rates; Hydraulics of Surface Irrigation; Irrigation for Mosquito Control; Sprinkler Irrigation Research; Installing Concrete Irrigation Pipe; and Drilling and Developing Irrigation Wells.

Wednesday Morning December 12

Four Concurrent Programs

(1) Soil and Water Program Erosion Control Group

Presiding: *John R. Carreker*, chairman, Erosion Control Group

9:00 Summary of Runoff and Erosion Control Research at Watkinsville, Georgia—*A. P. Barnett*, SWC, ARS, University of Georgia.

9:30 Minimum Tillage for Soil and Water Conservation—*George R. Free*, SWC, ARS, Ithaca, N. Y.

10:30 Soil and Water Program in India—*Ralph C. Hay*, University of Illinois.

11:10 Soil and Water Conservation Research in the United States—*Cecil H. Wadleigh*, SWC Research Branch, ARS, USDA, Beltsville, Md.

(2) Farm Structures Program

Presiding: *Merle L. Esmay*, chairman, Steering Committee, Farm Structures Division

9:00 New Developments on Horizontal Silos — *Walter D. Hunnicutt*, National Dairy Products Corp.

9:30 Tower Silos and Silage—*T. A. Meyer*, National Association of Silo Manufacturers.

10:00 Large Capacity Silos—*W. F. Mericle*, Martin Steel Products Corp.

10:30 New Developments in the Storage of Roughage — *LeRoy Reese*, A. O. Smith Corp.

11:00 Design and Placing of Precast Concrete Horizontal Silos—*Harold Revlett*, Ruby Lumber Co.

(3) Rural Electric Program

Presiding: *W. G. Buchinger*, vice-chairman, Rural Electric Division

10:00 What's New in Farm Wiring — *J. Vincent McBride*, Plastic Wire & Cable Co.

10:30 Heating Farm Homes with Electricity—(Heat Pump)—*H. S. Hinrichs*, Kansas Power & Light Co. (Resistance)—*Sterling Sanford*, Detroit Edison Co.

11:30 Comparative Costs of Various Methods of Farm Home Heating—*C. P. Davis, Jr.*, (AERB, ARB), USDA, Kansas State College.

(4) Joint Power and Machinery Division and National Joint Committee on Fertilizer Application

Presiding: *C. E. Guelle*, International Harvester Co.

9:00 Fertilizer Placement — (Soils and Plant Nutrition Problems)—*Firman E. Bear*, editor-in-chief, *Soil Science*, Rutgers University. (Engineering Problems)—*H. B. Walker*, University of California, Davis.

10:30 Machinery for Fertilizer Placement—*W. C. Hulburt*, (AERB, ARS), USDA, Beltsville, Md.

Wednesday Afternoon December 12

Three Concurrent Programs

(1) Joint Power and Machinery Program and National Joint Committee on Fertilizer Application

Presiding: *L. G. Kopp*, chairman, Power and Machinery Division

1:30 Fertilizer Placement for Grain Seedings in Permanent Sods—*L. N. Wise* and *T. N. Jones*, Mississippi State College.

2:00 Trends in the Use of Liquid Fertilizers—*William R. Bone*, Monsanto Chemical Co.

2:30 Developments in the Application of Liquid Fertilizers—*H. F. Miller* and *C. W. Gantt*, ARS, USDA, Beltsville, Md.

3:00 Phosphorus Solubility, Particle Size and Placement, as Related to the Uptake of Fertilizer Phosphorus and Crop Yields—*R. L. Cook, Kirk Lawton, L. S. Robertson*, and *C. M. Hansen*, Michigan State University.

(2) Soil and Water Program

Presiding: *E. H. Kidder*, chairman, Irrigation Group

1:10 Irrigation Water Requirements of Crops in the New England States—*Robert S. Palmer*, University of New Hampshire.

1:40 Comparison of Application Efficiency Under Surface and Sprinkler Irrigation at North Platte, Nebraska —*Bert R. Somerhalder*, University of Nebraska Agricultural Experiment Station.

2:10 Factors that Affect Distribution of Water from a Medium Pressure Rotary Irrigation Sprinkler—*Walter K. Bilanski* and *E. H. Kidder*, respectively, Ontario Agricultural College and Michigan State University.

2:40 Selection and Application of Electrical Equipment for Irrigation Pumping—*C. Young*, Irby Seay Corp.

(3) Rural Electric Program

Presiding: *Ross R. Mauney*, chairman, Rural Electric Division

1:30 Automation in Barn and Feed Lot—*Roger L. Clay*, Clay Equipment Co.

2:00 Discussion—*Elwood F. Olver*, Pennsylvania State University.

2:15 Development of Non-Siphoning Waterers—*J. S. Boyd*, Michigan State University.

2:45 Air Conditioning of Green Houses—*Joe Johnson*, Commonwealth Edison Co.

NEWS SECTION

Nominations Announced for 1957-58 ASAE Officers

NOMINATIONS for elective officers of the American Society of Agricultural Engineers for 1957-58, have been reported by the Nominating Committee, W. M. Carleton (chairman), G. W. Giles, J. Roberts, C. E. Ball and R. R. Raney. Voting will be by letter ballot to be mailed to voting members in February. Closure of voting will be March 31. Vacancies to be filled are those due to expiration of terms of office of three members of the Council at the time of the annual meeting in June, 1957. The nominees are as follows:

Nominee for President

Earl D. Anderson was born and raised in Boone County, Iowa. He received a B.S. degree in agricultural engineering from Iowa State College in 1931. Upon graduation he joined the staff of the Agricultural Experiment Station as research fellow in the agricultural engineering section. While preparing for an advanced degree he initiated a statistical study of rural fire losses in Iowa which has been continued through the years. He also conducted tests of strength and stiffness of laminated wood rafters, comparing those made by using newly-developed casein glue with rafters nailed and bolted. In 1932 he received an M.S. degree in agricultural engineering.

In 1934, he was employed by Farmers Mutual Re-Insurance Association in Grinnell, Iowa, to establish a loss prevention department for its affiliated companies in an effort to stem mounting fire and wind losses to insured farm risks. The inspection service, which was developed, was aimed at directing the farm policyholder's attention to any major fire or wind hazards on his property and making recommendations for correction. The earlier statistical study of fire losses provided an excellent background and was used as a guide for setting up this inspection service. Buildings on more than 12,000 farms were inspected by this department in the first 2½ years of operation. Reduction in losses resulted and lower insurance rates followed.

Through a keen understanding of farm building insurance he was able to initiate a uniform accounting system for county farm mutual companies and promoted the adoption of standard policy forms and classification of farm-risks to give preferred rates for safer farm building construction.

In the winter of 1935, Mr. Anderson was loaned to the Federal Housing Administration where he served as state farm representative for Iowa. The job entailed conducting an educational program on the use of Title I funds for repairing farm buildings.

He began 12 years' employment in 1936 with Republic Steel Corp. of Cleveland, and for five years was attached to the wire sales division in Chicago. In 1941, he transferred to the commercial research department in Cleveland. While with Republic, he conducted an educational program on better farm fence building and sponsored research aimed at improvements in attachment of galvanized sheets to farm buildings. He also directed research activities at a company-owned experimental farm to develop new uses for steel in farm buildings and dwelling construction.

In 1948, he joined the staff of Frank J. Zink Associates, consulting agricultural engineers, Chicago. His principal staff assignment was to serve as secretary of the National Sprayer and Duster Association. This was primarily public relations work, dealing with the problem of the manufacturers of equipment for applying the new agricultural chemicals such as 2-4, D and D.D.T. which had just been placed on the market. Also, he served a term as industry member on the board of directors of the North Central Weed Control Association. He is joint author of an article in the Yearbook of Agriculture, ("Insects") and has contributed frequently to trade and popular magazines on the subject of equipment for applying new chemicals.

In 1953, he accepted the position he now holds with Stran-Steel Corp., a unit of National Steel Corp. As director of agricultural extension, he has responsibility for dealer sales training programs, development of the product line of Quonset buildings and accessories for the farm market and is in charge of public relations in the farm field.

A member of ASAE since 1931, he served as member of its Council, 1947-50. He has served also as chairman of the Chicago Section, vice-chairman of the Michigan Section, chairman of the Farm Structures Division, and first chairman of the steering committee of the Farm Structures Division. For many years he represented ASAE on the farm fire protection committee of the National Fire Waste Council.

In college he was president of the Iowa State Student Branch of ASAE his senior year and agricultural engineering representative on the Engineering Student Council. He is a Member of FarmHouse, Alpha Zeta, Gamma Sigma Delta.

Mr. Anderson resides with his wife, Mary, in Grosse Ile, Mich. and attends the Presbyterian Church.

Nominees for Vice-President

Keith L. Pfundstein is a native of Illinois and in 1940 he received a B.S. degree in mechanical engineering from the University of Illinois.

After graduation he joined the Ethyl Corporation in Detroit, Mich., as a student engineer and the following year became sales engineer for the company in Denver, Colo. In 1942 he returned to Detroit to accept the position of research engineer. He was employed in the technical service department from 1943 to 1945 when he was appointed assistant manager of the agricultural engineering division.

In 1951 he became manager of the agricultural engineering division. This position entails responsibility for engineering and service work with the farm machinery and petroleum industries and with the agricultural schools. He has coordinated numerous programs of engine design and development as related to fuels in cooperation with the manufacturers of farm tractors and engines, and is a co-author of technical papers on engine design and performance.

Mr. Pfundstein joined the American Society of Agricultural Engineers in 1947. He

ASAE Meetings Calendar

November 16—QUAD CITY SECTION, Rock Island Works, J. I. Case Co.

November 16, 17 — TENNESSEE SECTION, University of Tennessee, Knoxville

November 30—OKLAHOMA SECTION, Student Union, Oklahoma A. & M. College, Stillwater

December 9 to 12 — WINTER MEETING, Edgewater Beach Hotel, Chicago

December 27, 28—PACIFIC COAST SECTION, University of California, Davis

February 4-6 — SOUTHEAST SECTION, Birmingham, Ala.

NOTE: Information on the above meetings, including copies of programs, etc., will be sent on request to ASAE, St. Joseph, Mich.

Nominee for President

EARL D. ANDERSON

Nominees for Vice-President

K. L. PFUNDSTEIN

W. J. RIDOUT, JR.

Nominees for Councilor

T. W. EDMINSTER

G. E. HENDERSON

has served as chairman of the Michigan Section, chairman of the Society's public relations committee, and has been an active member of various other committees of the Society. He is also a member of the Agricultural Committee of the Society of Automotive Engineers, Detroit Board of Commerce, and the Methodist Church.

William J. Ridout, Jr. was born in LaCrosse, Va., and received a B.S. degree in agricultural engineering from the Virginia Polytechnic Institute in 1939. His entire career has been devoted to farm electrification except for the time he spent in the U.S. Navy during World War II.

His first work upon graduation was with the Kentucky and West Virginia Power Co. at Pikeville, Ky. As rural service engineer, he worked at extending rural lines and showing farmers how to use electricity. After that he was employed by East Tennessee Light & Power Co. at Bristol, as a power engineer.

In 1941 he joined the South Carolina Extension Service at Clemson College as extension agricultural engineer in charge of farm electrification. He left the South Carolina Extension Service to enter military service. After being placed on inactive duty in 1945, he entered the Extension Service at North Carolina State College, Raleigh, in charge of farm electrification.

As a result of his work in the field of farm electrification, Mr. Ridout was offered the position of rural service manager for the Edison Electric Institute in 1947. In this position he worked closely with the farm departments of the various power companies, agricultural agencies, farm organizations and agricultural engineering departments throughout the United States. He also coordinated the activities of the farm committees of the Institute.

He was appointed editor of *Electricity on the Farm* magazine in 1951 and was named editorial director, January 1, 1956.

He has been a member of the ASAE since 1939, and has served the Society as chairman of the North Atlantic Section, and as chairman of the Rural Electric Division. He has been on numerous ASAE committees, and is presently a member of the Society's advisory committee to the U.S. Department of Agriculture on farm electrification research and the steering committee of the Rural Electric Division. He is also vice-chairman of the National Farm Electrification Conference and a member of the American Institute of Electrical Engineers.

Nominees for Councilor

Talcott W. Edminster is a native of Massachusetts and an engineering graduate (agricultural engineering major) from the University of Massachusetts in 1942. He received an M.S. degree in agricultural engineering from the University of Georgia in 1943.

His first employment following graduation in 1942 was as field construction engineer with the Turner Construction Co. in Boston. He resigned in the fall in favor of continuing his education as a graduate research assistant at the University of Georgia. In 1943 he joined the staff at the Virginia Agricultural Experiment Station, Blacksburg, as an assistant agricultural engineer. In this position he initiated a drainage research program in Virginia and assisted state cooperators in initiating irrigation studies. He co-developed with state and federal personnel the double-cut-plot mulch-tillage principle. Also, he formulated a program of research on farm pond seepage control.

He was transferred to the Soil and Water Conservation Research Branch (ARS), U.S. Department of Agriculture, Beltsville, Md., in 1953. He serves as assistant head, Eastern Soil and Water Management Section, and as work project leader for the federal drainage research program in the eastern 31 states. He is also responsible for the agricultural engineering phases of the irrigation, tillage, and erosion-control practices research programs of the section.

A member of the Society since 1942, he has served as vice-chairman of the Southeast Section and the Virginia Section. In 1953 he was vice-chairman of the Soil and Water Division, chairman in 1954, and in 1955, chairman of the Division's steering committee. Recently, he has succeeded President Bainer as chairman of the overall soil compaction committee. He has served as chairman of the Virginia chapter of the Soil Conservation Society of America and as chairman and member of the board of directors of the soil conservation section of the Association of Southern Agricultural Workers. He also holds membership in the American Geophysical Union, American Society of Agronomy, Soil Science Society of America, and the International Soil Science Society. He has been elected to Phi Kappa Phi and Sigma Xi. He is the recipient of both the USDA Superior Service Award and the William A. Jump Memorial Award "for exemplary achievement in public administration." He is a member of the Presbyterian Church.

He is co-author of "Soil and Water Conservation Engineering" a Ferguson Foundation Agricultural Engineering Series text.

George E. Henderson was born on a farm near Kenton, Ohio. He attended Ohio State University and graduated in 1929 with a B.S. degree in agriculture (major in agricultural engineering). He took additional work at Wittenberg College and the University of Tennessee.

Following graduation he became rural engineer with the Ohio Edison Co. at Springfield, and in 1932 he joined the Dayton Power and Light Co. at Wilmington, as rural engineer. From 1932 to 1949, he held the following positions with the Tennessee Valley Authority: Rural-electrification engineer in education, head of the educational section, assistant chief of the agricultural engineering division, chief of the division, and chief of agricultural engineering and food processing division.

In 1949 he became regional coordinator of the 12-state Southern Association of Agricultural Engineering and Vocational Agriculture, and professor of agricultural engineering at the University of Georgia.

Mr. Henderson has been an active member of ASAE since 1936. He has served as treasurer, then chairman of the Tennessee Section; secretary, then chairman of the Southeast Section, and has been a member of several of the Society's committees. He is presently a member of the Rural Electric Division steering committee, committee on farm fencing specifications, and committee on agricultural teacher training. He also holds memberships in Delta Theta Sigma, Phi Kappa Phi, Knoxville (Tennessee) Technical Society, University of Georgia Gridiron Club, and is an elder in the Presbyterian Church. He is the past vice-chairman of the National Farm Electrification Conference.

He is author and co-author of several agricultural engineering publications. During the past five years, four of these publications and two film strips won ASAE blue-ribbon awards in Annual Meeting extension exhibits.

Nominees for Nominating Committee

Rex F. Colwick, agricultural engineer, coordinator, regional cotton mechanization project, State College, Miss.

Julian M. Fore, associate professor of agricultural engineering, North Carolina State College.

Price Hobgood, agricultural engineering department, A & M College of Texas.

Mack M. Jones, chairman, agricultural engineering department, University of Missouri.

Clarence F. Kelly, associate agricultural engineer, University of California.

Frank B. Lanham, head, agricultural engineering department, University of Illinois.

Ross R. Mauney, manager, rural sales and development, Arkansas Power and Light Co.

Charles K. Otis, agricultural engineering department, University of Minnesota.

Earl T. Swink, head, agricultural engineering department, Virginia Polytechnic Institute.

John H. Wessman, consumers relations department, International Harvester Co.

Tobacco Workers' Conference

THE Tobacco Workers' Conference was held August 27-30 at London, Ontario, Canada. Paul N. Winn, Jr., assistant research agricultural engineer, University of Maryland, was elected chairman of the engineering section, and James L. Shepherd, head, agricultural engineering, Georgia Coastal Plain Experiment Station, Tipton, was named vice-chairman.

The section program covered the problems of an engineering nature regarding different types of tobacco. Progress reports were given on research studies which are being carried on by the different states and Canada, and included mechanical harvesting, irrigation and curing.

Field trips were taken to the Tobacco Sub-Station at Delhi, Ontario, to see the research work being done on the flue-cured type of tobacco grown in Canada, and to the Experimental Station, Science Service Laboratory, Harrow, Ontario, to see the experimental work being done on burley type tobacco as grown in Canada.

The next meeting of the Tobacco Workers' Conference will be held in Georgia during the winter of 1957.

Third International Irrigation Congress to Meet in U. S.

THE third congress of the International Commission on Irrigation and Drainage will meet at the Sheraton-Palace Hotel in San Francisco, Calif., April 29-May 4, 1957. Delegates of 34 member countries will attend, and the United National Committee extends an invitation to anyone interested in world progress in irrigation and drainage to be present.

The committee expects a record attendance because of the growing concern with water problems. Questions to be discussed on the program will cover four subjects—canal lining; soil-water relationship in irrigation; hydraulic structures on irrigation and drainage systems; and the interrelation between irrigation and drainage. Each country or national committee may submit reports on problems in irrigation and drainage development and practice, and on problems of freeboard in irrigation channels, weed control, and ground water.

An exhibit has been planned to show new practices, equipment, and machinery. Following the technical meeting study tours

have been planned to private and public water developments and to plants which manufacture irrigation equipment and machinery. These tours will also include an inspection of irrigation development and research at the University of California's agricultural experiment station. Other tours of interest and information are also planned.

Further Information may be obtained from the United States National Committee, International Commission on Irrigation and Drainage, P.O. Box 7826, Denver 15, Colo.

Heads New AE Department at University of Kentucky

DRAYTON T. KINARD has been named head of the newly established agricultural engineering department of the University of Kentucky. Formerly he was professor of agricultural engineering at the University of Georgia.

D. T. KINARD

Born in Dillon, S.C., he attended Clemson College where he received a B.S. degree in agricultural engineering in 1933. In 1941 he graduated from Virginia Polytechnic Institute with an M.S. degree and later received a Ph.D. degree in agricultural engineering from Michigan State University.

After his graduation from Clemson College Mr. Kinard joined the Soil Conservation Service in Spartanburg, S. C., as an engineering aid. In 1936 he moved to Montgomery, Ala., to work with the Farm Security Administration, and in 1937 he became associated with the Daniel T. Duncan civil engineering firm in Columbia, S. C., where he worked for three years as a laboratory engineer. He was an engineer for R. H. Bouligny, Inc. until 1940 when he became a graduate research assistant at the Virginia Polytechnic Institute. He did research for a year while working for the M.S. degree. Mr. Kinard joined the University of Georgia staff in 1941 as a research associate and became a professor of agricultural engineering in 1955. He is author and co-author of several articles pertaining to agricultural engineering.

The University of Kentucky plans a full agricultural engineering department program with a professional curriculum in agricultural engineering within a year, which will be administered jointly by the college of agriculture and home economics, and the college of engineering. Prior to the 1956-57 academic year, this field was a section of the agronomy department. The new department is housed in a fully-equipped building with classroom facilities, laboratories and offices.

Mr. Kinard will direct and supervise the agricultural engineering program in teaching, research and extension. He will be assisted by the following staff members: James B. Kelley, professor of agricultural engineering, who has headed the agricultural engineering section for 37 years; Earl G. Welch, agricultural engineer with the University for 36 years, who was cited recently by the U. S. Department of Agriculture for outstanding service in promoting agricultural engineering in Kentucky; Kermit Mills, extension agricultural engineer; J. B. Brooks, assistant professor of agricultural engineering; and Earl Young, associate professor of agricultural engineering.

This building houses the newly established agricultural engineering department at the University of Kentucky, Lexington. The department plans a full agricultural engineering program within a year

Dr. Tukey to Address R E Division Luncheon

DR. H. B. TUKEY, head, horticultural department, Michigan State University, will speak at the noon luncheon meeting, sponsored by the Rural Electric Division of the ASAE, December 10. He will speak on the subject of atomic energy and its application to modern agriculture.

H. B. TUKEY

He is a graduate of the University of Illinois, receiving a B.S. degree in 1918 and an M.S. degree in 1920. In 1932 he received a Ph.D. degree from the University of Chicago.

Dr. Tukey was awarded the Jackson Dawson Medal in 1949, by the Massachusetts Horticultural Society, for his work in developing dwarf fruit trees, plant breeding of tree fruits and small fruits and rootstocks for fruit trees. He is the author of several books and articles pertaining to horticulture.

He was a delegate of the U.S. Government in 1955 to the conference on peacetime uses of atomic energy held in Switzerland. During the spring of 1956 he was a member of an eight-man team which toured southeastern Asia and studied the possibilities of establishing a nuclear center in Manila. He is chairman of the Athletic Committee of Michigan State University and the University Big Ten representative.

Correction Notice

THE caption for the picture at the top of page 690 of AGRICULTURAL ENGINEERING for October has been reported in error in indicating that M. S. Klinck attended the organization meeting of the North Atlantic Section in 1925. He is a native of New York state and during most of his professional career has worked in the North Atlantic Section area, but his name does not appear on a list of charter members of the Section.

A question has also been raised as to whether Orval French and President Roy Bainer are properly classified as "Old Timers." Since this is a relative term, we leave it to the individual views of their many friends.

Roumanian Engineers Meet

ASAE members are invited to attend the Roumanian Scientific Association of Engineers and Technicians (55,000 members) Congress in Bucharest on November 14-18. During the stay in Roumania, all expenses will be supported by their association. Our Department of State encourages participation and would like to have the names of ASAE members who plan to attend this Congress. Limited details available at ASAE Headquarters, 420 Main St., St. Joseph, Mich.

Thor Research Center Features Agricultural Engineering

AGRICULTURAL Engineers and agricultural engineering had a prominent place in the October 1 and 2 opening and dedication of the Thor Research Center for Better Farm Living, at Huntley, Illinois.

Roy Bainer, President of ASAE, was the opening speaker at the Seminar on the first day. "Mechanical Horses—The Crops They Bring and the Men Who Guide Them," was the title of his talk.

V. J. Morford, professor of agricultural engineering at Iowa State College, spoke of farm shop tools as "Hired Hands with No Demands." His talk emphasized the place of shop equipment in the overall productive operating program of the modern farm.

The research viewpoint and approach to farm and other problems was presented by Dr. Karl F. Butler, farm counselor, Avco Manufacturing Corp., in a talk on "Research and Its Eternal Race with Tomorrow." Neil C. Hurley, Jr., president, Thor Power Tool Co., welcomed the group. Dean Clyde C. Murray, University of Georgia, served as moderator.

A specially invited group of more than 100, including many of the heads of college agricultural engineering departments or their representatives, extension leaders and directors of agricultural education attended the Seminar.

The second day, which was open to the public, featured an inspection of the Model Farm Shop, field demonstrations, an FFA building contest, and an address by Ezra Taft Benson, Secretary of Agriculture.

Located on an operating dairy farm near Huntley, the Thor Research Center for Better Farm Living has been planned to explore and develop the usefulness of farm shops and shop equipment in the maintenance and adaptation of farm equipment, together with possibilities for farm home improvement projects.

. . . New Windrower equipped with

Engineers find Double Cogs best for traction drive on self-propelled windrowers

To get the dependable, full power transmission they wanted, International Harvester Co. engineers working on the new McCormick No. 161 self-propelled Windrower chose Dayton Double Cog-Belts.

The new windrower, a center delivery implement with the lowest platform angle in the market—23°—is powered by a 25 h.p. engine. To meet all field conditions, the single-lever, hydraulic platform of the "161" Windrower can be adjusted from 3"—32" in height, and a variable speed drive gives 7 forward speeds—from 2½ - 8½ m.p.h. at the touch of a foot pedal.

Essential to this variable speed traction drive is a V-Belt that will maintain correct, uniform speed ratios. To International Harvester engineers, this meant the Dayton Double Cog-Belt. Long experience with these exceptional V-Belts has proved their dependable performance.

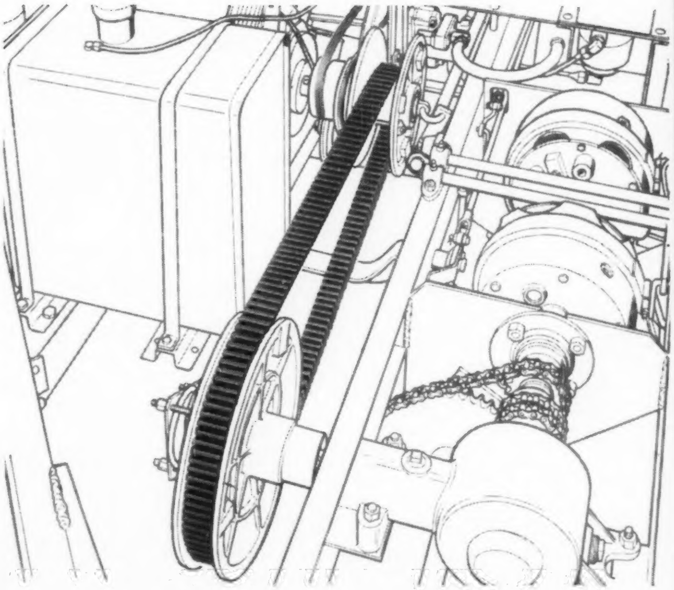
Dayton Double Cogs are used with complete success on all International Harvester self-propelled combines. Tested against competitive V-Belts for this particular application, they were immediately approved.

Many implement design engineers have seen in-the-field performance over long periods prove the superiority

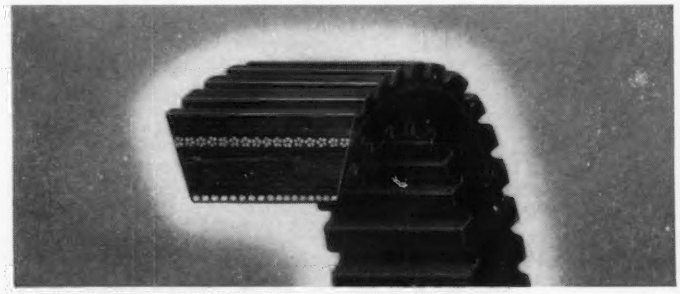
Dayton Double Cog-Belt*

of Dayton Double Cog-Belts for variable speed traction drives. Like International Harvester, they use them consistently because they can depend upon them. For information or help in solving any power transmission problems, call the Dayton Agricultural Engineer at the nearest Regional Office or write to The Dayton Rubber Co., Agricultural OEM Div., 400 W. Madison St., Chicago 6, Ill.

For any crop you want to windrow, International Harvester Co. offers the McCormick No. 161 self-propelled Windrower. With a low angle, center delivery platform available in 12 or 16 ft. widths, the new windrower lays uniform rows for easier combining and baling with minimum shatter losses.



To maintain accurate speed ratios on the variable speed traction drive, International Harvester engineers chose Dayton's Double Cog-Belt. Cross-wise rigidity assured by the exclusive double cog design and the maximum power transmitted by the die cut raw edges give it a serviceability far beyond any other type V-Belt for this purpose.



Dayton Double Cog-Belt, closest approach to the theoretical ultimate in V-Belt design, offers the highest pull-out torque of any V-Belt made. For its effective depth, it provides a higher degree of longitudinal flexibility than any other V-Belt design. At the same time, it is capable of withstanding maximum axial pressures.

*T. M.

Dayton Rubber

First in Agricultural V-Belts

Agricultural Sales Engineers in Atlanta, Chicago, Cleveland, Dallas, Dayton, Moline, New York, San Francisco and St. Louis

Howard M. Ellis, specialist in charge of agricultural engineering extension for the North Carolina Extension Service and a member of ASAE since 1937, was given the annual Man-of-the-Year Award of the Sprinkler Irrigation Association. The award was presented at the association's convention held in Washington, D. C.

This award is made to an individual, usually selected from the academic field, who over the years has contributed to the advancement of sound sprinkler irrigation design and practices. Mr. Ellis has worked closely with farmers, distributors, and dealers throughout the state in promoting good design and operation of systems, and his efforts have had an influence on the design of systems throughout the southeast.

He is a native of North Carolina and was appointed head of agricultural engineering work for the North Carolina State College Extension Service in 1948. He has been a specialist since 1936.

Howard F. Peckworth has been named as director for District 8 of the American Society of Civil Engineers. Mr. Peckworth is managing director of the American Concrete Pipe Association, with offices in Chicago. He is also managing director of the American Concrete Pressure Pipe Association, Concrete Pipe Associations, Inc., and the American Concrete Agricultural Pipe Association.

Roger M. Cleveland has been appointed assistant manager of the agricultural department of the Masonite Corp., Chicago, Ill. He received a B.S. degree in agricultural engineering at Iowa State College in 1947, and an M.S. degree from the same school in 1948.

For the past two years he has been a farm building contractor in Webster City, Iowa. Prior to that time he was with the Reynolds Metals Co. in their Farm Institute, and in 1949 and 1950 he was assistant professor of agricultural engineering at the University of Arkansas.

Carroll E. Worlan has joined the sales department of Iowa Power and Light Co. in Des Moines, where he will work in the area development field.

He has been assistant to the executive secretary of the Iowa Utilities Association in Des Moines for the past three years. In his new job he will coordinate the community and farm development programs of the company in a 26-county area of central and southwestern Iowa.

Wesley F. Buchele has accepted the position of associate professor of agricultural engineering at Michigan State University. He will specialize in the field of farm power and machinery research and graduate teaching. Mr. Buchele is a native of Kansas, and has been on the staff at University of Arkansas and Iowa State College, where his work in connection with a tandem tractor method, soil density measuring developments and a threshing device are of particular note.

Merle L. Esmay of the structures section of the agricultural engineering department, Michigan State University, has been named graduate supervisor for the department. His experience in several phases of agricultural engineering, in addition to the structures work, will be of assistance in guiding the graduate program at the university.

Bruce H. Anderson has been appointed extension irrigation specialist in Utah. He was formerly with the USOM in Iran.

ASAE MEMBERS in the News

Howard M. Ellis, left, specialist in charge of agricultural engineering extension at No. Carolina State College, has been named Man-of-the-Year by the Sprinkler Irrigation Association. David S. Weaver, director of the North Carolina Extension Service, congratulates Ellis on his award

Wiley H. Henson, Jr. has joined the agricultural engineering department at North Carolina State College to work with a team of scientists on the problems of tobacco curing.

He is an employee of the farm electrification section of the agricultural engineering research branch, ARS, USDA, cooperating with the N. C. Agricultural Experiment Station on the project.

He received a B.S. degree in agricultural engineering from the University of Georgia in 1952 and an M.S. degree from the North Carolina State College in 1956.

Max B. Williams has joined the staff of Ben Pearson, Inc., Pine Bluff, Ark., as chief engineer of the company's cotton picker division. He was previously associated with the Oliver Corp. at South Bend, Ind.

William W. King has accepted a position as assistant sales manager with Meyer Products, Inc. in Cleveland, Ohio.

H. P. Smith, professor of agricultural engineering at Texas A&M College, is now in Dacca, East Pakistan, where he will serve as chief advisor for a contract between the Texas A & M College and the University of Dacca and affiliates. This contract is for the improvement of the educational programs and facilities in the University of Dacca and its affiliated colleges. He will serve in Pakistan for two years.

C. K. Beeman, formerly assistant product engineer for J. I. Case Co. in Burlington, Ia., has transferred to the Bettendorf Works, as a supervisor of product engineering.

Peter A. Boving has joined the staff of the University of California, Davis, as assistant specialist in drainage. He was formerly research officer at the Dominion Experimental Farm, Swift Current, Saskatchewan, Canada.

Howard D. Bartlett, formerly associate agricultural engineer, agricultural engineering department, University of Maine, has accepted a position as associate professor of agricultural engineering, Pennsylvania State University. His new duties will include working on poultry housing and poultry house equipment.

Curt L. Oheim, vice-president of Deere & Co., Moline, Ill., has been appointed adviser on farm equipment and machinery to the Business and Defense Services Administration, U. S. Department of Commerce. He is on loan to BDSA from Deere & Co.

He has been associated with Deere & Co. for 37 years, and at one time served the government as director of the National Production Authority. He is also vice-president and director of the Leece-Neville Co., Cleveland, Ohio, and a member of the Society of Automotive Engineers and of the executive committee of the Farm Equipment Institute.

Mardis R. Warner resigned his position as extension agricultural engineer, agricultural engineering dept., University of Maryland, and has returned to the University of Maine where he was an extension agricultural engineer.

Robert Rae has been appointed associate principal of the Brandon Agricultural and Homemaking School and assistant agricultural representative in the Brandon district, by the Manitoba Department of Agriculture, Canada.

Kenneth Von Bargen has resigned his position from Lockwood Graders, Inc. of Gering, Nebr., to join the staff of the agricultural engineering department at the University of Nebraska.

Paul Colbenson, of the Douglas Fir Plywood Association, has transferred from the technical department in Tacoma, Wash., to the field promotion department in Birmingham, Ala.

Harry Manges has resigned his position of area engineer with the U.S. Soil Conservation Service and has accepted the position of irrigation engineer with the agricultural engineering department at Kansas State College in Manhattan.

Albert E. Rust, formerly employed in the engineering department of the Oliver Corp. at South Bend, Ind., has accepted a position in the engineering department of the Caterpillar Tractor Co.

Roy T. Tribble has left the employ of the Oldfield Equipment Co., Cincinnati, Ohio, to accept the position of agricultural engineer at the Pineapple Research Institute in Honolulu, Hawaii.

Eric R. Doughty, previously an instructor of agricultural engineering at the University of Connecticut at Storrs, has accepted a position as the farm department representative for the Central Maine Power Co., Portland.

NECROLOGY

Frank J. Stablein, tractor engineer with Ethyl Corp., died suddenly October 16 in Rochester, N.Y., while on a business trip for the company. He was associated with Ethyl Corp. for 24 years and had wide experience in the farm tractor field. At his death, he was Eastern regional tractor engineer for the company.

Mr. Stablein was born March 11, 1893, in Edina, Mo. He received a B.S. degree in engineering from the Missouri State University in 1920.

He was a member of the Knights of Columbus, the American Legion, and has been a member of ASAE since 1937.

Mr. Matt Huber shows off his 129 Fertilizer Distributor.

USS COR-TEN High Strength Steel

increases strength, reduces weight, decreases corrosion in Fertilizer Distributor

The J. I. Case Company, Racine, Wisconsin, is a long-time manufacturer of farm equipment. A great deal of experience lies behind the choice of USS Cor-Ten High Strength Steel for its new fertilizer distributor. USS Cor-Ten Steel is used in the hopper of the 129 Fertilizer Distributor to give it greater strength, save weight, and to decrease corrosion from exposure to all kinds of weather. When the long, narrow hoppers are filled with heavy fertilizer, a heavy stress is put on the hopper as it is pulled across rough, uneven fields. The use of USS Cor-Ten Steel eliminates considerable additional bracing and framework which would be necessary if USS Cor-Ten were not used.

Mr. Matt Huber, farmer, Ellison Bay, Wisconsin, is an enthusiastic user of the 129 Fertilizer Spreader. "The two other fertilizer distributors I owned were heavy, bulky and difficult to handle. All that is solved with my new, lightweight 129 Distributor. USS Cor-Ten Steel plays the big role in giving rugged performance with less dead weight. I expect this distributor to last at least 20 years, and I like the fact that maintenance is no trouble at all."

USS Cor-Ten, a high-strength low-alloy steel, has a yield point 1½ times that of regular carbon steel, has 4 to 6 times the resistance to atmospheric corrosion, has 50% higher fatigue strength and offers superior resistance to abrasion and impact. For more information on this quality steel, and its applications to farm equipment of many types, contact the nearest District Sales Office of United States Steel. Just ask for a free booklet on USS Cor-Ten Steel.

NOW AVAILABLE!

Our "Design Manual for High Strength Steels" contains comprehensive and practical information that you will find extremely useful in designing your product for greater economy and efficiency by the sound use of high strength steels.

For your free copy, write on your company letterhead, giving your title or department, to United States Steel Corporation, Room 5541, 525 William Penn Place, Pittsburgh 30, Pa.

UNITED STATES STEEL CORPORATION, PITTSBURGH · AMERICAN STEEL & WIRE DIVISION, CLEVELAND · COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
NATIONAL TUBE DIVISION, PITTSBURGH · TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. · UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS COR-TEN High Strength STEEL

UNITED STATES STEEL

Integral Stabilizer Nose

McDowell Mfg. Co., Pittsburgh 9, Pa., has introduced a new style stabilizer nose to its line of irrigation couplings and fittings.

This fitting is designed to keep dirt from

getting inside irrigation pipe couplings. It is an integral part of the coupling, and eliminates the time-consuming job of attaching separate stabilizers on the line. Units are available in 2, 3, 4 and 5-in sizes.

New-Type Corn Harvester

Lundell Mfg. Co., Cherokee, Iowa, has developed a corn harvester which does not employ gathering chains or sprockets for cutting and moving material to the cylinder.

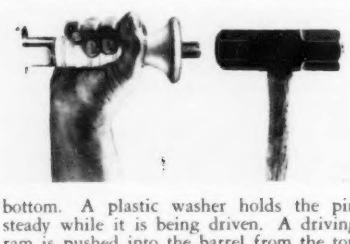
The new machine has only one main working part. It cuts corn and sorghum

crops a few inches from the ground, chops and loads in one operation. It will also convert to a forage harvester to take hay standing or out of swath by simply removing the corn attachment. The cut can be varied from fine to coarse by using 2, 3, 4 or 6 knife combinations.

Nail Driver for Concrete

Omark Industries, 5001 S.E. Johnson Creek Blvd., Portland 6, Ore., has developed a new hand tool for driving nails into concrete, cinder blocks and soft metals.

The tool concentrates the force of a hammer blow to the head of a hardened steel drive pin. In operation a drive pin is inserted into the barrel of the tool from the

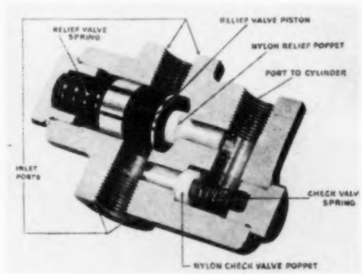


bottom. A plastic washer holds the pin steady while it is being driven. A driving ram is pushed into the barrel from the top of the tool. The tool is then held against the concrete while 2 or 3 hammer blows are struck on the driving ram head. This forces the drive pin into the concrete. The plastic washer disintegrates at the last hammer blow leaving a clean fastening. Four types of drive pins in more than 30 sizes are available.

NEW PRODUCTS CATALOGS

Valve Prevents Seepage

Webster Electric Co., Racine, Wis., has developed a new lock valve designed to provide a positive seal for hydraulic cylinders against seepage which causes a hydraulic lift system to slip. The valve can handle up

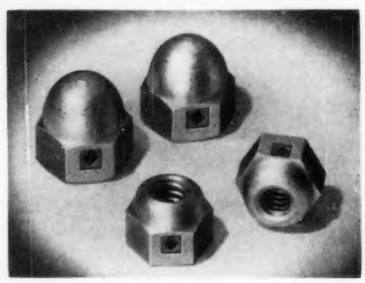


to 20 gpm and is said to operate satisfactorily up to 1500 psi. The manufacturer says that it can be applied to almost any hydraulic lift system used in tractors, road building equipment, lift trucks, and machine apparatus.

Nylon-Lined Cap Nuts

The Nylok Corp., 611 Industrial Ave., Paramus, N. J., has introduced a new line of "thru-tapped" self-locking cap nuts.

A tough resilient pellet of nylon is permanently imbedded in each nut. The pellet



projects beyond the threads, and when engaged, is compressed by the mating threads. As the pellet attempts to regain its original shape, it reportedly sets up a counter-thrust and creates a strong metal-to-metal contact. Tests have indicated that they can withstand temperatures ranging from −70 to above 250 F.

Electric Motor Bulletin

Robbins & Myers, Inc., Motor Division, Springfield, Ohio, has published a bulletin featuring new 10 and 15-hp capacitor-start, capacitor-run single phase motors.

The 2-color, 4-page bulletin describes features of the new motors, which provide protection against the weather, debris and small field animals. Such features include location of the condensers and centrifugal switch mechanism for easy inspection while the motor is operating; undercoating for all steel parts; the spraying of the rotor and shaft with a rust inhibitor; an anti-corrosion primer for cast iron parts; the use of a non-hardening compound to seal power leads and pack the terminal box; the sealing of the double-width ball bearings to keep the grease in, dust and dirt out; and ventilation from end to end which keeps the motors clean and cool-running.

New Rod Weeder

International Harvester Co., 180 N. Michigan Ave., Chicago 1, Ill., has announced a new center-drive rod weeder, available in either 12 or 14-ft sizes. Operating principle of the weeder is to pull a ⅞-in square steel rod, at a right angle to the direction of travel, just below the surface of the ground.

The rod, roller chain-driven from both

main wheels of the weeder, revolves in the opposite direction to the forward movement of the machine. It is reported that when the rod is pulled through the ground just below the surface and is revolving at the same time, weeds are torn out by the roots and deposited on the surface.

The rod, supported by steel points that control penetration, extends wider than the drive wheels on the weeder and erases wheel tracks. The steel points are reversible for double wear, and long, high beams and wide spaced wheels provide clearance for heavy trash. The center-drive from both wheels permits easy multiple hookups and provides for continuous turning of the rod on turns.

New Mounted Implements

Tractor and Implement Div., Ford Motor Co., Birmingham, Mich., has introduced two new mounted implements designed for plowing, mulching, fallowing, terracing and controlling weeds in areas where conservation farming is practiced.

Shown is a new 4½-ft one-way plow. The other new implement is a disk tiller available in 2½ and 3-ft sizes. These new, fully-

mounted implements feature tubular steel frames and high-carbon, heat-treated steel disks turning on sealed ball bearings. The disk tillers use 26-in disks, four in the 2½-ft model and five in the 3-ft model. The one-way plow uses eight 22-in disks.

Simple adjustments are provided for angle of cut. Leveling, depth and pitch are controlled from the tractor seat with the 3-point linkage and hydraulic system.

Irrigation Pump Bulletin

Ralph B. Carter Co., 192 Atlantic St., Hackensack, N. J., will send on request a copy of Bulletin 5059, a new 4-page catalog on irrigation pumps. The new bulletin contains many photos of pumps and cutaway sections, and describes construction features of the company's line of irrigation pumps. It also includes selection curves indicating the performance range for various sizes and models—as well as a section on speed increaser pumps for use with tractor PTO systems. *(Continued on page 772)*

New Products and Catalogs

(Continued from page 770)

Steel Post Driver

Dillon's Dilly Driver Co., Galva, Ill., has announced a new steel fence post driver, which can be attached to any hydraulic loader.

The new driver features a hollow steel shaft which is bolted to the cross-bar of the hydraulic loader by means of a special clamp. The driver shaft fits over the steel post to keep it plumb and is said to prevent twisting or turning of the post under pressure. An adjustable guide attachment on the side of the driver shaft enables the operator to set each post to a desired depth. By disconnecting the driver shaft and running a chain or rope through the clamp, posts can be pulled.

Starter for Gasoline Engines

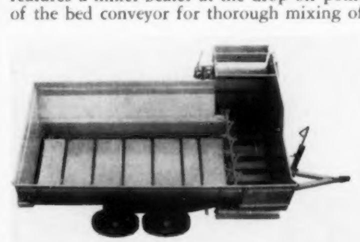
Clinton Machine Co. of Maquoketa, Iowa, and Clinton, Mich., has announced two new electric starters for the company's Gem and Panther series engines. They can be adapted

also for use on many other types of small air-cooled gasoline engines, it is said.

The new 6-volt starter is equipped with a clutch, 35-amp battery, cable ground and mounting bolts. The 110-volt model comes with a clutch, 8-ft extension cord, and mounting bolts.

Improved Feeder Wagon

The Kelly Ryan Equipment Co., Blair, Nebr., has announced production of an improved version of its Model 55 self-unloading feeder-forage wagon. The new model features a mixer-beater at the drop off point of the bed conveyor for thorough mixing of



feeds. It is available in two basic sizes—150 bu and 180 bu. By adding additional side extensions, capacity can be extended to 220 bu. The new model can be purchased with a single or tandem axle, 4-wheel running gear, or truck mounted. It is of all-steel welded construction, and is delivered complete with tires and tubes.

(Continued on page 774)

Products of French & Hecht Division of Kelsey-Hayes

for the workhorses of modern agriculture

From the monsters of the fields to the highway vehicles that whisk the final product off to market—wheels are vital to the speed and efficiency of modern mechanized farming.

Making wheels for agriculture is a Kelsey-Hayes specialty that started 67 years ago at the French & Hecht Farm Implement and Wheel Division in Davenport, Iowa.

KELSEY-HAYES

Kelsey-Hayes Wheel Co., Detroit 32, Mich. • Major Supplier to the Automotive, Aviation and Agricultural Industries

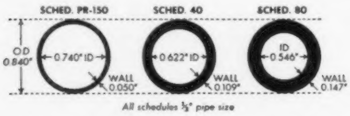
14 PLANTS ***Automotive:*** *Detroit and Jackson, Michigan; McKeesport, Pa.; Los Angeles, Calif.; Windsor, Ontario, Canada* • ***Aviation:*** *Jackson, Michigan; Springfield, Ohio (SPECO Aviation, Electronics and Machine Tool Division); Utica, New York—4 plants—(Utica Drop Forge and Tool Corporation, a subsidiary)* • ***Agricultural:*** *Davenport, Iowa (French & Hecht Farm Implement and Wheel Division)*

New Products and Catalogs

(Continued from page 772)

Polyvinyl Chloride Pipe

The Alloy Tube Div., The Carpenter Steel Co., Union, N. J., has introduced a new line of light wall polyvinyl chloride pipe designed for uniform pressure rating in all sizes and suitable for many agricultural applications.



This series, known as schedule PR-150, represents an addition to the firm's recently announced schedules 40 and 80 pipe. The thinner wall and larger inside diameter give it greater flow capacity than the other series in the same nominal pipe sizes.

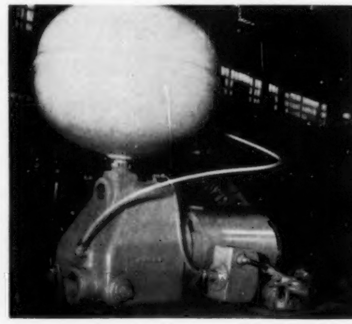
There are two basic types in the new series. One has high chemical resistance and a maximum working pressure of 150 psi at 75 F. The other has high impact strength and a rating of 125 psi at the same temperature. This pipe is available in eight sizes ranging from ½ to 4 in. Wall thicknesses range between 0.05 and 0.23 in. All pipe in the series is furnished in standard 10 and 20-ft lengths with plain ends.

A full line of socket solvent cement fittings is available. Threaded joints are not suitable with this line. The size can be formed, sawed, machined, hot-gas welded and solvent cemented with metal and wood working equipment.

New Polyamide Tubing

The Polymer Corporation of Pennsylvania, Reading, Penna., has announced the use of corrosion-resistant polyamide tubing on a recent line of ejector-type water pumps. The tubing serves as pressure switch tubing between the pump case and the pressure switch of a ¼ to 1-hp horizontal ejector.

The new tubing requires no deburring or



prebending. It is simply cut to length with a sharp knife and installed with standard metal compression fittings. Also it can be applied with the same type fittings as those used with copper tubing. The flexible tubing when used as air lines under pressures of 17 to 40 psi takes a perfectly symmetrical bend between connections. It is said to have long-term resistance to vibration and flexural fatigue, and high resistance to abrasion and impact.

Power Transmission Booklet

Lovejoy Flexible Coupling Co., Dept. AES, 4800 W. Lake St., Chicago 44, Ill., has published a new 12-page illustrated technical brochure, which describes a full line of power-transmission equipment, including flexible couplings, variable-speed pulleys and transmissions, universal joints and motor bases. Information includes operating data, horsepower ratings, sizes and types for countless applications and working conditions.

Flexible couplings described are of the non-lubricated type with ratings from fractional to 3,000 hp.

Universal joints described are recommended for slow-speed applications up to 100 rpm with ratings from ½ to 207 hp.

Two New Bowstring-Truss Grain Storage Buildings

Stran-Steel Corp., Ecorse, Detroit 29, Mich., has added two new bowstring-truss grain storage buildings to its Quonset steel building line. Approximate capacity of one of the new structures, a 60 x 96-ft with 20-ft eaves, is 77,355 bu. The new bowstring 50-ft and 60-ft buildings have eave heights of either 15 or 20 ft. The 15-ft high building permits grain to be loaded 14 ft, 2 in high; the 20-ft high building allows grain to be piled 16 ft high.

The buildings come in various lengths and may be added to when necessary in 16-ft increments. Grain capacities of the 50-ft wide structures, with a standard length of 96 ft, are 64,335 bu for the 20-ft eave height and 53,235 bu for the 15-ft eave height. The 60-ft wide buildings have grain capacities of 77,355 bu for the 20-ft eave height and 64,200 bu for the 15-ft eave height.

The new buildings also feature a grain storage and cooling system which controls surface crusting and hot spots. The cooling unit, combined with double-wall construction, is said to eliminate the need of turning grain and permits storing for indefinite periods.

NEW BULLETINS

Manpower and Education, by the Educational Policies Commission of the National Educational Association of the United States and the American Association of School Administrators. (Prices, cloth bound $1.75 per copy; paper bound, $1.25 per copy.) Copies may be obtained from the National Educational Association, 1201 Sixteenth St., N.W., Washington 6, D.C.

This 128-page report discusses the problem of the manpower situation and includes recommendations for education. It states that the key to meeting manpower needs is in the fullest possible education of all Americans.

The report is divided into three parts. Part I reviews the prominent features of the manpower situation in the United States as they have been mentioned by specialists in the field. The second part suggests certain value criteria in terms of which the manpower situation should be approached. The final section traces some of the major implications in the manpower situation for American schools and colleges, and presents the commission's suggestions for educational policy.

ASTM Manual for Rating Motor Fuels by Motor and Research Methods, by the American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa. Prepared by ASTM Committee D-2 on Petroleum Products and Lubricants. $6.75.

The 192-page manual was written to assist qualified personnel in installing and operating knock testing equipment for both the motor and research methods. It was prepared to revise previous ASTM methods for determining the knock characteristics of motor fuels and to serve users of knock test engines by providing appendices with factual information and data on the operation and maintenance of knock testing equipment. The manual is illustrated and includes short statements on the essential features of each method.

Drainage of Agricultural Land, Miscellaneous Publication No. 713, May, 1956, U.S. Department of Agriculture. This 200-page paper bound book is a bibliography which contains selected, annotated references to literature published between 1936 and 1955 on the drainage of land for farming. Subjects included are methods and techniques, equipment, soil science and hydrology as related to drainage problems, needs and effects of drainage, descriptions of specific projects in different countries, and drainage law and financing of drainage projects in the United States. Drainage for mosquito control and drainage of forests have been included, but references on drainage of land for non-agricultural uses have been omitted except when techniques described are applicable to agricultural projects. Because of the importance of the ground-water problem in the western states to drainage questions, references on ground water in this area have been included, even when they do not relate specifically to drainage.

Material in languages other than English has been limited to the practical aspects of drainage. The bibliography is arranged according to a subject classification, and is provided with a combined author, subject, and geographic index.

Copies may be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. Price is 60 cents per copy.

NIAE Bulletins. The following bulletins have been received recently from the National Institute of Agricultural Engineering, Wrest Park, Silsoe, Bedfordshire, England:

Test of The Bomford Hedge-Maker Minor —R126. The bulletin reports a test made of the Bomford hedge-maker minor, a two-man tractor-mounted hedge cutting machine with a cutter bar designed to cut stems of up to 1½ to 2-in in diameter.

A Detailed Procedure of Testing for Hammer Mills and Other Farm Grinding Mills—TM 129, by P. Hebblethwaite and R. Q. Hepherd. The test procedure outlined is intended to provide the manufacturer who wishes to send his machine for test, with a knowledge of what information would be collected on the performance of his machine in a complete test. The method of carrying out the test work is described.

An Investigation Into the Performance of Five Typical Methods of Measuring Moisture Content of Grain—R46, by M. G. R. Warner and G. O. Harries. The available rapid methods are divided into a few broad categories and the performance of one typical commercial instrument from each category was investigated.

Soil Loads on Plow Bodies (Part 2)—TM 105, by O. J. J. Rogers and J. C. Hawkins. The results are given of the measurement of the system of forces acting on three types of plow body over a range of speeds under five distinct conditions of plowing.

NEW BOOKS

Machines in Agriculture, by George Segler. Published by Verlag Paul Parey, Hamburg and Berlin. Price, 32.40 German Mark.

The aim of this book is to provide the agricultural student and interested farmer with a review of all applications, performances and output of farm machinery used presently in Germany.

The book is illustrated with more than 400 pictures and charts. Rather than describe the various differences in design of present commercially available farm equipment it shows how basic problems and their variations can be solved with available farm equipment.

The approach to the subject of farm mechanization from the standpoint of farm operations makes this book unique not only for the German farmer and agricultural student but wherever farm crops are grown and processed.

Induction Heating Practice, by D. Warburton-Brown. Cloth, 6x9 inches, 192 pages. Illustrated and indexed. Philosophical Library, Inc., 15 East 40th St., New York 16, N. Y. $10.00.

This book is a practical handbook on the application of the high-frequency induction heating process to brazing, soldering, hardening, annealing, tempering and other heating requirements in engineering. It is intended for the production engineer or executive interested in the possibilities of installing or extending induction-heating equipment, for the foreman or operator with the day-to-day job of operating (and sometimes adapting) such equipment, and for others concerned with heat treatment in engineering production.

From experience, the author gives information on the design of work-coils and inductors, on modifying the design of components or assemblies to facilitate use of the process, and on jigs or handling mechanisms. The last part of the book deals with various applications, first giving general notes on each and then specific examples, with production data. The examples cover a wide range, from the motor and motor accessory industries to typewriters, gold-melting, electrical components and precision instruments, while a complete chapter is devoted to the special problems of gear hardening.

Resistance of Stored Crops to Air Flow, by R. J. Matthies, Braunschweig, Germany. Published by Institut für Landmaschinen, Braunschweig, Mühlenpfordtstr, 23. Price, 15.00 German Mark.

This book was written to determine the relations between the resistance of agricultural crops (small grains, root crops and forage) to air flow and the independent variables affecting this resistance based upon Reynolds law of similarity.

Beginning with earlier, similar, research work, the author's studies resulted in obtaining a universal formula for the resistance of small grain and root crops to air flow. A new formula was derived which is valid for all kinds of forage and foliage crops.

The results of investigation on the influence of the dumping heights of crops and the manner of dumping are of interest for practical applications. The book reports that recent measurements have confirmed results previously found for packed beds of material other than farm crops and that the resistance to air flow in dumped crops varies inversely proportional to the fourth power of the porosity.

Applicants for Membership

The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Beeman, James F. — Graduate student in agricultural engineering, Pennsylvania State University, University Park, Pa.

Beldin, Royal L. — Junior engineer, John Deere Spreader Works, East Moline, Ill. (Mail) 517 N. Howell, Davenport, Iowa

Benton, James T. — Agricultural engineer, (SCS), USDA (Mail) PO Box 808, Cleveland, Miss.

Campbell, Edwin J. —Design engineer, East Moline Works of International Harvester Co., East Moline, Ill.

Dorsey, Marion U.—Graduate trainee, Tractor and Implement Div., Ford Motor Co., Birmingham, Mich. (Mail) 605 W. Hudson, Royal Oak

Everett, Bernard A. — Research assistant, economic research dept., Deere and Co., Moline, Ill.

Gable, Wyatt T., Jr.—Design engineer, International Harvester Co., Memphis, Tenn. (Mail) 915 Par Rd.

Gould, Roland F.—Trainee, Eastern States Farmers Exchange Inc., West Springfield, Mass. (Mail) 84 Pearl St., Essex Junction, Vermont

Hagan, Robert M.—Associate professor of irrigation, University of California, Davis, Calif.

Hotes, Frederick L.—Associate professor of civil and irrigation engineering, University of Calif., Berkeley 4, Calif. (Mail) Rm. 12 Engineering Bldg.

Johannes, Bruwer J.—Graduate student in agricultural engineering., University of Pretoria, Pretoria, South Africa (Mail) 1116 No. 37th St., Lincoln, Nebr.

Kotyuk, Frank — Conservation aid, (SCS), USDA (Mail) RR 1, Bridgman, Mich.

Lewis, Albert C.—Associate research engineer in agricultural engineering, Iowa State College, Ames, Iowa (Mail) 1004 Garfield Ave.

Mack, Robert S.—Engineering trainee, New Holland Machine Div. of Sperry-Rand Corp., New Holland, Penn. (Mail) 124 Conestoga St.

Palmer, John W. A.—Agricultural engineer, Dominion Experimental Station, Box 780, Swift Current, Saskatchewan, Canada

Preedy, Ernest L. — Assistant experimental aide in agricultural engineering, State College of Washington, Pullman, Wash. (Mail) 1718 A St.

Ricketts, J. F.—District manager, The Fafnir Bearing Co., New Britain, Conn. (Mail) 1907 Seventh Ave., Moline, Ill.

Snyder, Herman C. — Test engineer, East Moline Works of International Harvester Co., East Moline, Ill. (Mail) 2758 Cooltown Rd.

Stapp, Harry K. — Design engineer, East Moline Works of International Harvester Co., East Moline, Ill.

Timberlake, John R. — Design engineer, Memphis Works of International Harvester Co., P.O. Box 268, Memphis, Tenn.

Todd, Robert R. — Agricultural engineer, (SCS), USDA (Mail) Liberty Bldg., Paoli, Ind.

Waund, Dunrith, Jr. — Trainee, experiment station, Hawaiian Sugar Planters Assn., HSPA, Honolulu, Hawaii

Webb, Byron K.—Assistant agricultural engineer, Clemson College, Clemson, S. C. (Mail) 101 Riggs Dr.

Webb, J. C.—Junior agricultural engineer, Agricultural research center, Farm Electrification section, Beltsville, Md.

Wilkerson, George S.—Education manager, Midland Ford Tractor Co., Box E, Robertson, Mo. (Mail) 219 Rand Drive, St. Louis 21

Williams, Alan F. — Assistant to manager, product engineering, H. V. McKay Massey-Harris Pty., Ltd., Sunshine, Victoria, Australia

Yerkes, Dean H.—Project engineer, Allis-Chalmers Mfg. Co., 3rd and Badger St., La Crosse, Wis.

Transfer of Membership Grade

Basselman, James A.—Editor and publisher, AGRICULTURAL ENGINEERING and AGRICULTURAL ENGINEERS YEARBOOK (Mail) 420 Main St., St. Joseph, Mich. (Associate Member to Member)

Endahl, Lowell J. — Agricultural engineer, National Rural Electrical Co-op. Assn., 1303 New Hampshire Ave. N.W., Washington 6, D. C. (Associate Member to Member)

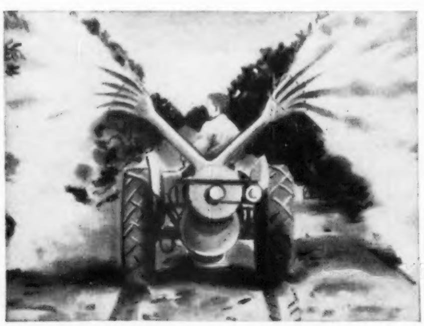
Hale, Edward B. —Associate extension agricultural engineer, University of Tennessee (Mail) PO Box 1071, Knoxville 7, Tenn. (Associate Member to Member)

Jennings, Norman R.—Manager of engineering division, Pennsylvania Farm Bureau Co-op. Assn., 2609 Derry St., Harrisburg, Pa. (Associate Member to Member)

McFate, Kenneth L.—Leader in agricultural engineering, University of Missouri, Columbia (Mail) 108 Agricultural Engineering Bldg. (Associate Member to Member)

HERE'S WHAT SEALMASTER IS DOING FOR THE FARMER

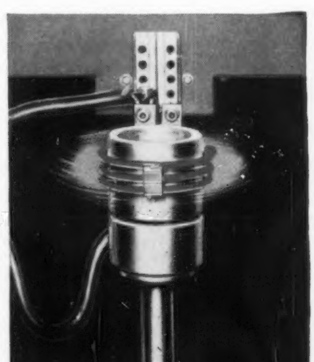
Top performance with longer service and less maintenance . . . that's the SEALMASTER record on quality farm machinery all over the world. Today's farmer looks to SEALMASTER for his guarantee of quality when he buys equipment. He knows that SEALMASTER'S exclusive combination of features meet the demands of his most rugged operation. There's the patented labyrinth seal, self alignment, floating retainer and many others . . . INCLUDING . . .



ZONE HARDENING

for Positive Race to Shaft Locking

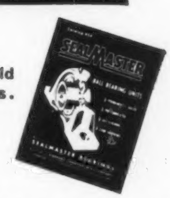
This patented SEALMASTER feature is of particular importance to the farm field where positive locking of bearing race to shaft is vital to smooth, continuous machinery performance. The inner race ring is induction heat treated through ball path only, leaving the extended portions in their original metallurgically soft, tough state. Hardened set screws are tightened through the soft extension to provide firm race to shaft locking. Shaft wear is eliminated and fretting corrosion is reduced, assuring top bearing performance.



SEALMASTER

BALL BEARING UNITS

Bulletin 454 should be in your files. Write for it today!



SEALMASTER BEARINGS A DIVISION OF STEPHENS-ADAMSON MFG. CO., 67 RIDGEWAY AVENUE, AURORA, ILLINOIS

PERSONNEL SERVICE BULLETIN

NOTE: In this bulletin the following listings current and previously reported are not repeated in detail; for further information see the issues of AGRICULTURAL ENGINEERING indicated. "Agricultural Engineer" as used in these listings is not intended to imply any specific level of proficiency or registration as a professional engineer. Items published herein are summaries of mimeographed listings carried in the Personnel Service, copies of which will be furnished on request. To be listed in this Bulletin, request form for Personnel Service listing.

POSITIONS OPEN — JANUARY — O-534-790. FEBRUARY — O-4-602, 29-606. MARCH — O-60-608, 60-609, 71-611, 80-612. APRIL — O-115-614, 117-615, 117-616, 119-617. MAY—O-133-620, 155-621. JUNE — O-165-623, 166-624, 166-625, 159-627, 175-630, 179-631, 181-632, 181-633. JULY — O-183-634, 180-636, 198-637, 215-638, 216-639. AUGUST — O-233-640, 234-641, 217-643, 239-644, 240-645, 244-647, 262-648. SEPTEMBER — O-271-650, 305-651, 307-652, 232-653, 314-654. OCTOBER — O-330-655, 316-656.

POSITIONS WANTED — JANUARY — W-457-60, 528-61. FEBRUARY—W-8-1, 18-5, 30-6, 37-7. APRIL—W-50-11, 96-14, 43-15. MAY—W-125-17, 139-18, 143-19. JUNE—W-161-20. JULY—W-190-23. AUGUST—W-283-26. SEPTEMBER — W-284-27, 308-29, 359-30. OCTOBER — W-315-31, 323-33, 328-34, 332-35.

NEW POSITIONS OPEN

AGRICULTURAL ENGINEERS (3) for extension specialist work in (1) farm structures and rural housing, (2) crop processing, and (3) soil and water fields, in a midwestern state. MS degree in agricultural engineering, or equivalent, or BS degree and interest in earning MS. Some experience in teaching, extension, or with industry in sales or research. Good health. Able to travel. Able to meet people easily and to express thoughts clearly. Permanent staff positions in agricultural engineering department, with opportunity to progress and to transfer to other positions in department, based on capabilities. Federal and state retirement and insurance available. Congenial staff and good working conditions. Central location keeps travel to a minimum. Salary open, based on qualifications and experience. O-252-657

AGRICULTURAL ENGINEER, instructor, to teach physics and rural electrification to agricultural students, with opportunity for graduate study toward MS or PhD, in a north central state university. Age under 40. BS deg in agricultural engineering or equivalent, from accredited curriculum. Good academic aptitude. No work experience required. Appointment for full time or part time, depending on desired rate of graduate study program. Salary $448 per month for full time. O-363-658

AGRICULTURAL ENGINEER for farm safety work. Responsible for technical phases of safety program, with national organization. Midwest location. Some travel. Age, under 45. BS degree in agricultural engineering. Experience in extension work and contacts with farm equipment industry. Able to make friends and give leadership to an important program. Excellent opportunity for advancement. Salary open. O-372-659

SOILS RESEARCH AND DEVELOPMENT ENGINEER for work on colloidal canal linings in a western state college. Age 25-40. MS degree in agricultural engineering or equivalent. BS degree considered if strong in chemistry. One year work experience preferred. Interest and ability in laboratory techniques. Temporary position with good prospect for becoming associated with new method of canal lining. Salary $4000-6000, depending on qualifications. O-365-660

IRRIGATION ENGINEER for research and development on colloidal canal linings in a western state college. Age 25-40. MS degree preferred. BS degree considered if experience adequate. One or more years including irrigation opreations experience preferred. Able to work with irrigation operations people. Temporary position with good prospect for bceoming associated with new method of canal lining. Salary $4500-6500, depending on qualifications. O-365-661.

IRRIGATION OR HYDRAULIC ENGINEER for research, principally on groundwater, in a western state college. Age 24-45. MS degree or PhD essential. Three or more years experience with groundwater, irrigation and hydraulic engineering. Research-minded and able to work with public. Permanent position. Excellent opportunity to advance on Experiment Station staff, and to do a small amount of teaching. Salary $5200-7000 range. O-365-662

AGRICULTURAL ENGINEER for work as extension specialist in farm structures in a midwestern state. Age, under 40. B.S. degree in architecture or B.S. degree in agricultural engineering with considerable specialization in structures work. M.S. degree desirable. Candidates without M.S. degree should be willing to work for it in order to be considered. Must like working with people, be interested in helping farmers solve their building problems; and able to help organize extension program. Excellent opportunity for well qualified man. Employment is for expansion of staff from 3 to 4 farm building extension specialists, each assigned to a specific area of the state, with opportunity to develop his own program in that area. Applicants should furnish college transcript, personal record, experience, and list of published writings. Salary open, depending on experience and training. O-382-663

NEW POSITIONS WANTED

AGRICULTURAL ENGINEER for production or development work on power and machinery with manufacturer or consultant, anywhere in USA. Single. Age 24. No disability. Available March 15, on completion of 2-year tour of active commissioned service in US Air Force. BS degree in agricultural engineering, 1954, Pennsylvania State University. Farm background. Production trainee 8 mo before call to military service. Salary open. W-255-36

AGRICULTURAL ENGINEER for development, extension, research or service in soil and water field with public service agency or distributor in west or northeast. Married. Age 35. No disability. Available on reasonable notice. BS degree in agricultural engineering, 1950, Pennsylvania State University. Experience in service of heavy earth moving equipment, engineering drafting with aircraft manufacturer, junior engineer with manufacturer of tillage equipment, and engineering in oil field pumping equipment. War enlisted and commissioned service in Navy, 3½ yr. Salary open. W-379-37

Index to Advertisers

Professional Directory

RATES: 80 cents per line per issue; 40 cents per line to ASAE members. Minimum charge, five-line basis. Uniform style setup. Copy must be received by first of month of publication.

Agricultural Engineers Yearbook

Supply of the 1956 edition of AGRICULTURAL ENGINEERS YEARBOOK has been exhausted. Copies of the 1955 edition are still available at $3.00 per copy postpaid.

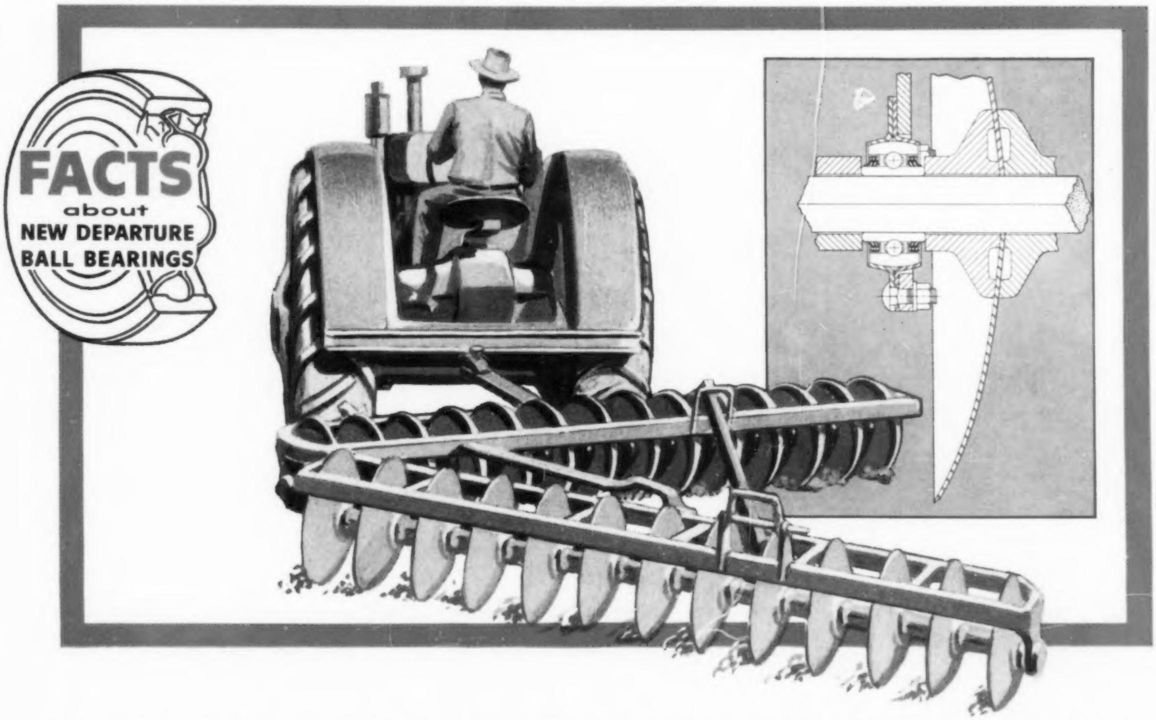
Send order with remittance to
American Society of Agricultural Engineers
St. Joseph, Michigan

ADVERTISING REPRESENTATIVES

Chicago 2:
Dwight Early & Sons
100 North LaSalle St.
Tel. CEntral 6-2184

New York 17:
Billingslea & Ficke
420 Lexington Ave.
Tel. LExington 2-3667

Los Angeles 43:
Justin Hannon
4710 Crenshaw Blvd.
Tel. AXminster 2-9501



FOUR-YEAR FIELD TEST PROVES DEPENDABILITY OF NEW DEPARTURE DISC HARROW BEARINGS!

No failures in more than four years of tests!

Here's proven dependability with a bonus! For this performance by New Departure heavy-duty disc harrow bearings includes the economy of virtually zero maintenance. With efficient triple-lip seal design, lubricant is sealed *in*, dirt, dust, and wear sealed *out*. Extra-heavy rings give maximum shock resistance . . . insure dependable service under severe operating conditions.

Implement manufacturers save, too, with these ball bearings . . . available in square or round bore. Simple, inexpensive mounting eliminates the need for expensive component parts.

Use the handy dimension chart below for more information about New Departure farm implement bearings. Or, write direct for full details to New Departure, Division of General Motors, Bristol, Connecticut.

Available in square or round bore with spherical O.D., for flange mounting. Also with cylindrical O.D., for "TRUNNION" hanger mount.

PRINCIPAL DIMENSIONS FOR TYPE III BEARINGS

Bearing No.	Shaft Size	Out. Dia.	Width		Stamped Flange No.
Sealed	Nominal	Spherical	Inner	Outer	
AS4508FC	⅞" Square	3.438	1.688	1.312	FL87
AS4508AC	1" Square	3.438	1.688	1.312	FL87
AS4508BC	1⅛" Square	3.438	1.688	1.312	FL87
AS4511AC	1½" Square	4.125	1.750	1.438	FL105*
AS4508DC	1⅛" Round	3.438	1.688	1.312	FL87
AS4509BC	1¾" Round	3.438	1.688	1.312	FL87

*See New Departure representative for availability.

Ball Bearings Make Good Machines Better

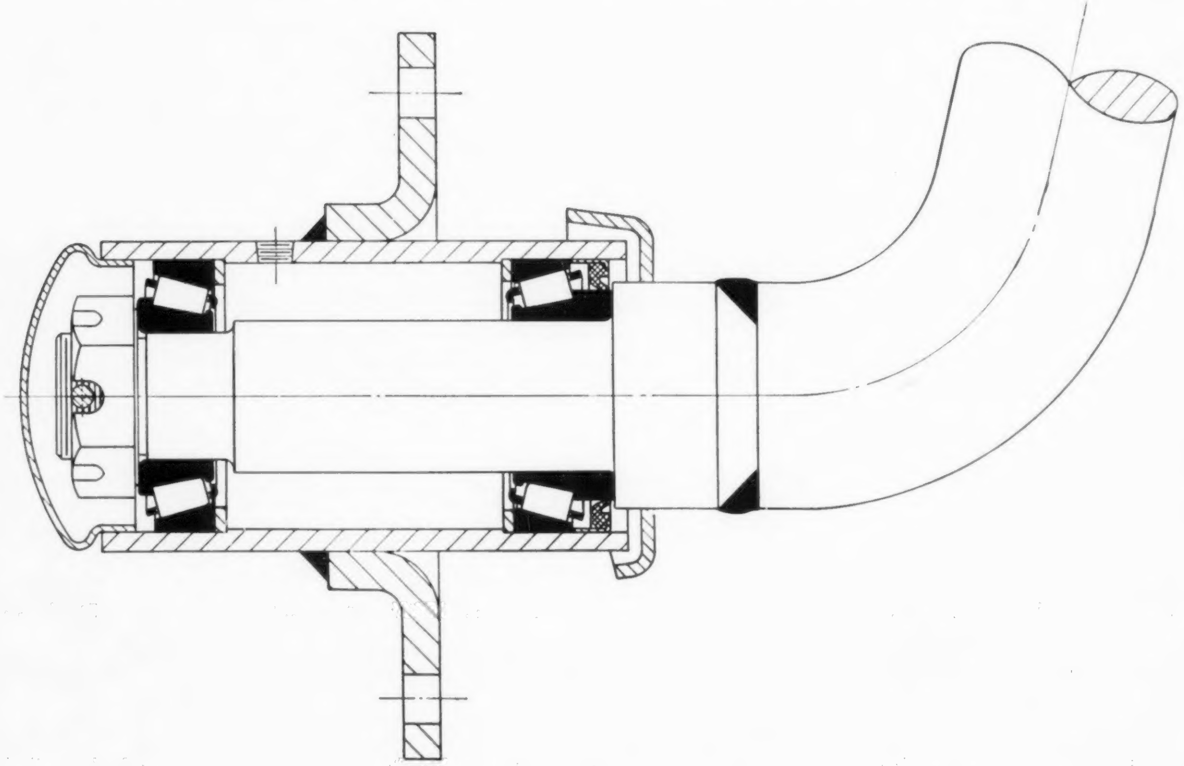
WATCH "WIDE WIDE WORLD"
SUNDAYS—NBC-TV

NEW DEPARTURE
BALL BEARINGS

GM
GENERAL MOTORS

NOTHING ROLLS LIKE A BALL

How I-H Engineers Solved 4 Problems on Main Plow Wheel with 1 Kind of Bearing



THESE were the four tough problems that faced International Harvester engineers: how to handle thrust loads while operating in deep dirt; how to keep this dirt out of the bearings; how to provide for towing at full tractor speeds on the highway; how to cut production costs.

I. H. engineers solved all four of these problems by mounting the main plow wheel on Timken® tapered roller bearings. And they were able to add another advantage for the farmer—once-a-season lubrication.

Timken bearings handle the tough thrust loads as well as the radial loads, or any combination. That's because of their tapered construction. Closures are more effective, too, because Timken bearings hold housings and shafts concentric. Lubricant stays in—dirt stays out.

Whether the plow's being towed to the job or pulled in the field, operation is easy. Why? Because the true rolling motion and precision manufacture of Timken bearings practically eliminate friction.

In addition to all these advantages, International Harvester found that the use of Timken bearings cut their production costs. The Timken Company furnished a tube assembly which could be welded to the flange. Wheel hub machining was completely eliminated.

The Timken Company engineers will be glad to help you with your bearing problems. For more information, write for your copy of "Timken Roller Bearing Practice in Current Farm Machinery Applications". It's free. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

The farmer's assurance of better design

TIMKEN Tapered Roller BEARING EQUIPPED

NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL AND THRUST — LOADS OR ANY COMBINATION